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**Tab**

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(45) **Date of Patent:** **Jan. 28, 2003**

(54) **BICYCLE HUB WITH SPOKE SEAL**

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(73) Assignee: **Shimano Inc.**, Osaka (JP)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Jan. 31, 2000**

(51) **Int. Cl.**<sup>7</sup> ..... **B60B 27/00**

(52) **U.S. Cl.** ..... **301/59; 301/110.5**

(58) **Field of Search** ..... **301/59, 110.5, 301/110.6, 57**

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(57) **ABSTRACT**

A bicycle hub is provided with spoke openings that extend into the interior of the hub. The bicycle hub basically has a hub axle, a hub body and a seal arranged in the hub body. The hub axle has a center axis extending between a first end and a second end. The hub body has an interior passageway with the hub axle being rotatably supported therein. The hub body also has a set of first spoke openings circumferentially arranged around one end of the hub body and a set of second spoke openings circumferentially arranged around the other end of the hub body. The spoke openings of the hub body are arranged for use with tangential bicycle spokes having a straight section and a bent end with an enlarged head such that straight section extends at an angle of about 95° relative to the bent end. A first seal is arranged in the interior passageway of the hub body and adjacent the first spoke openings to isolate the first spoke openings from the hub axle. A second seal is arranged in the interior passageway of the hub body and adjacent the second spoke openings to isolate the second spoke openings from the hub axle. Preferably, the seals is arranged in the interior passageway of the hub body to form first and second isolated spaces of the interior passageway below the first and second spoke openings.

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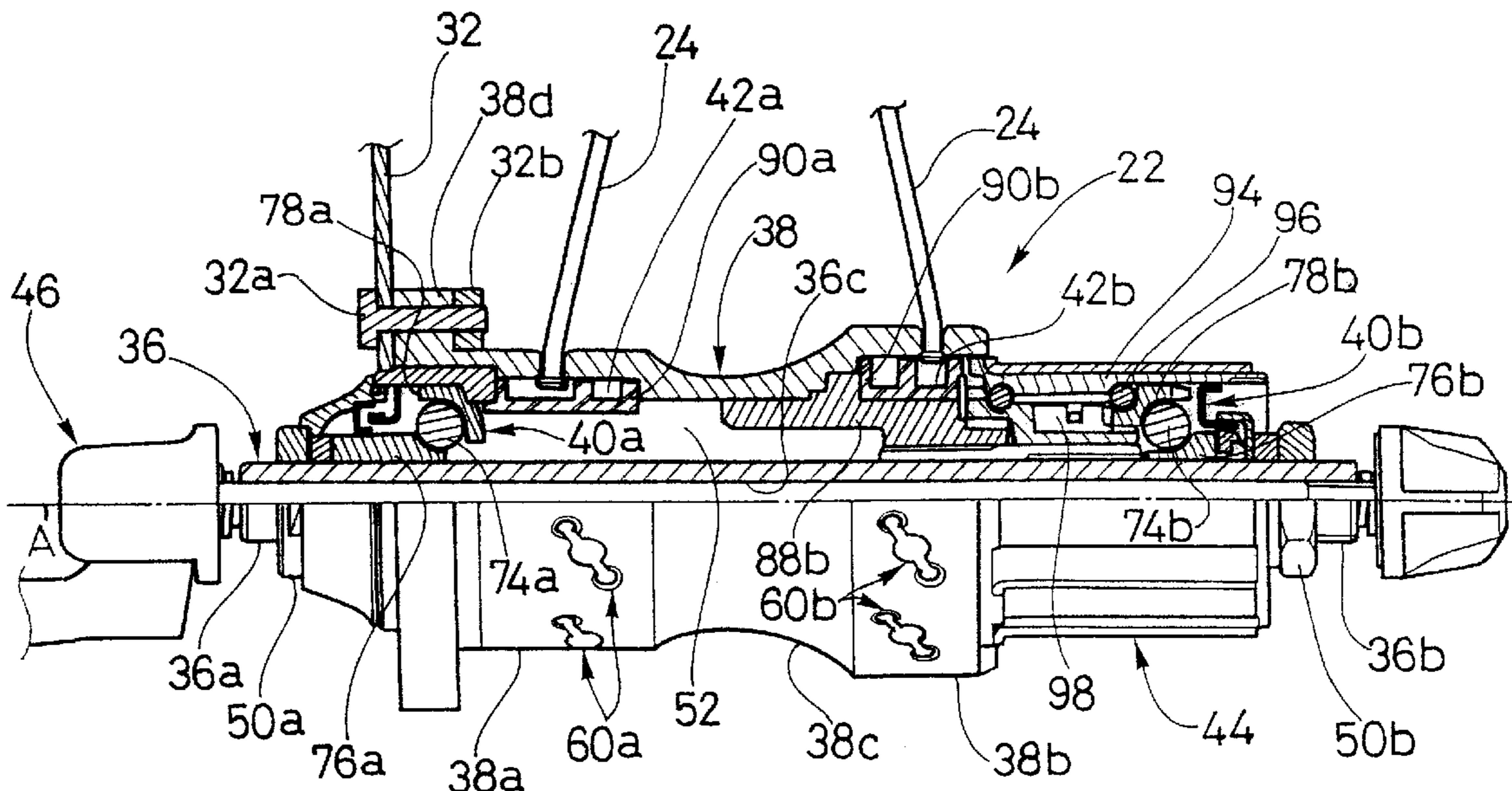
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**30 Claims, 16 Drawing Sheets**



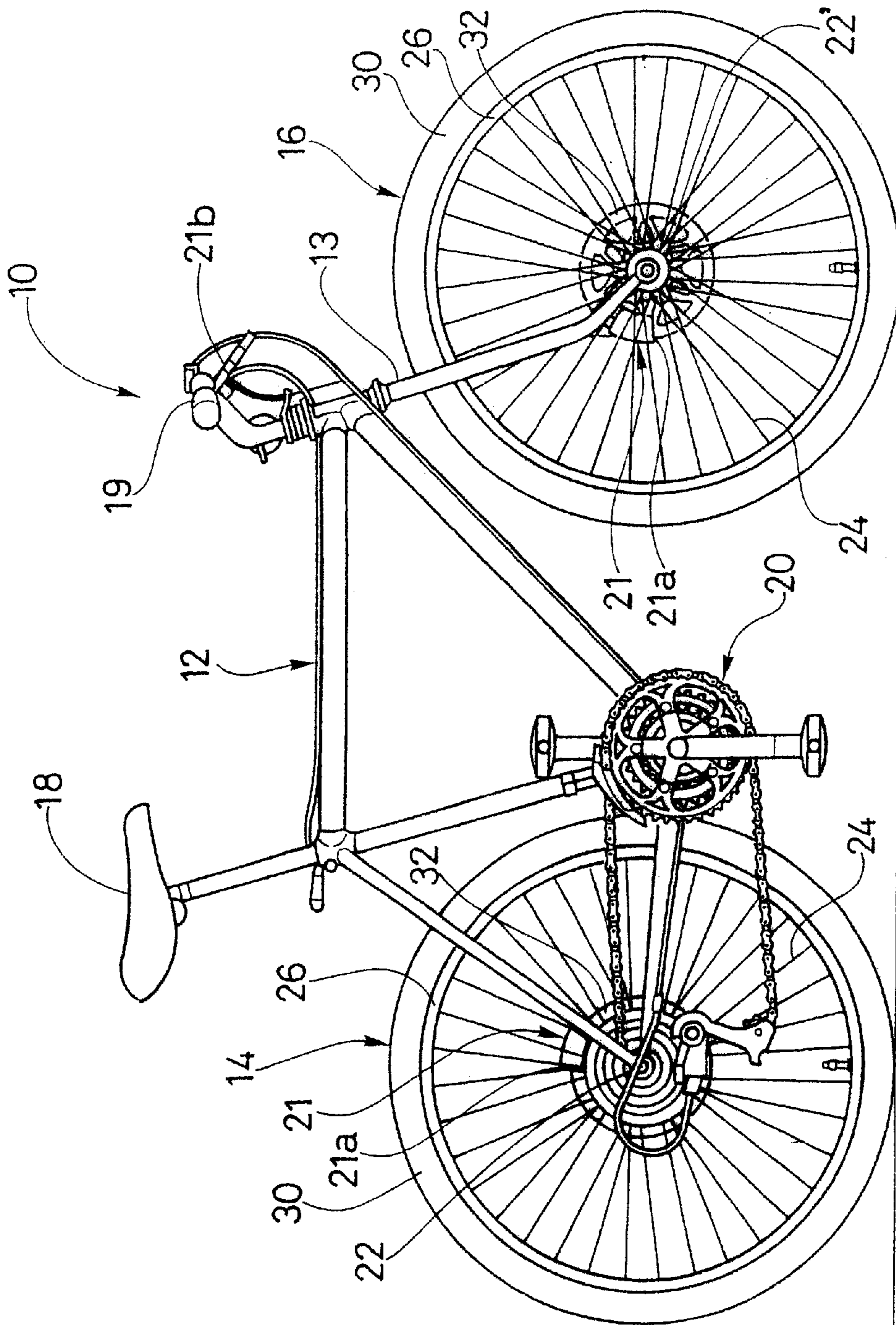


FIG. 1



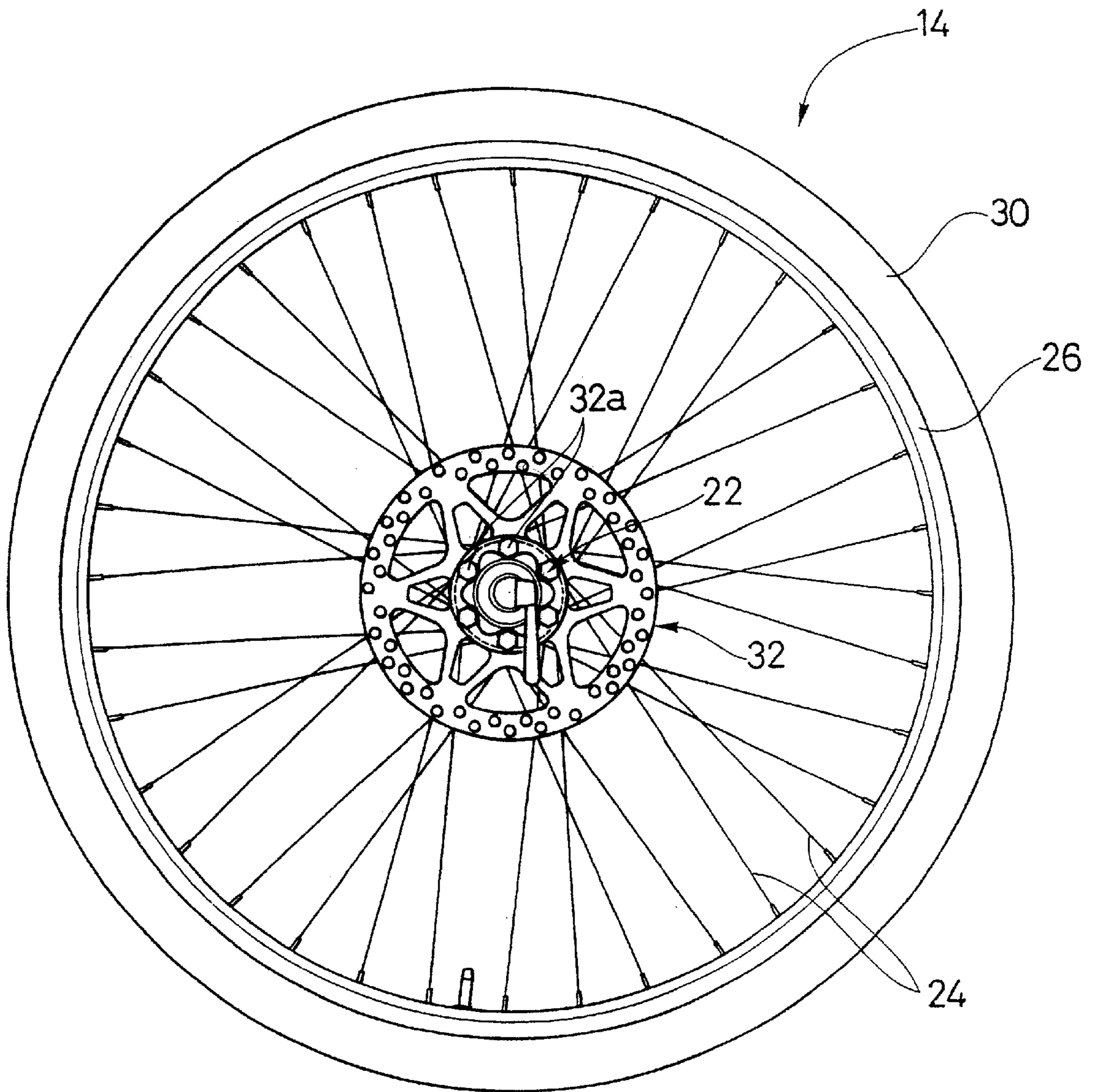


FIG. 2

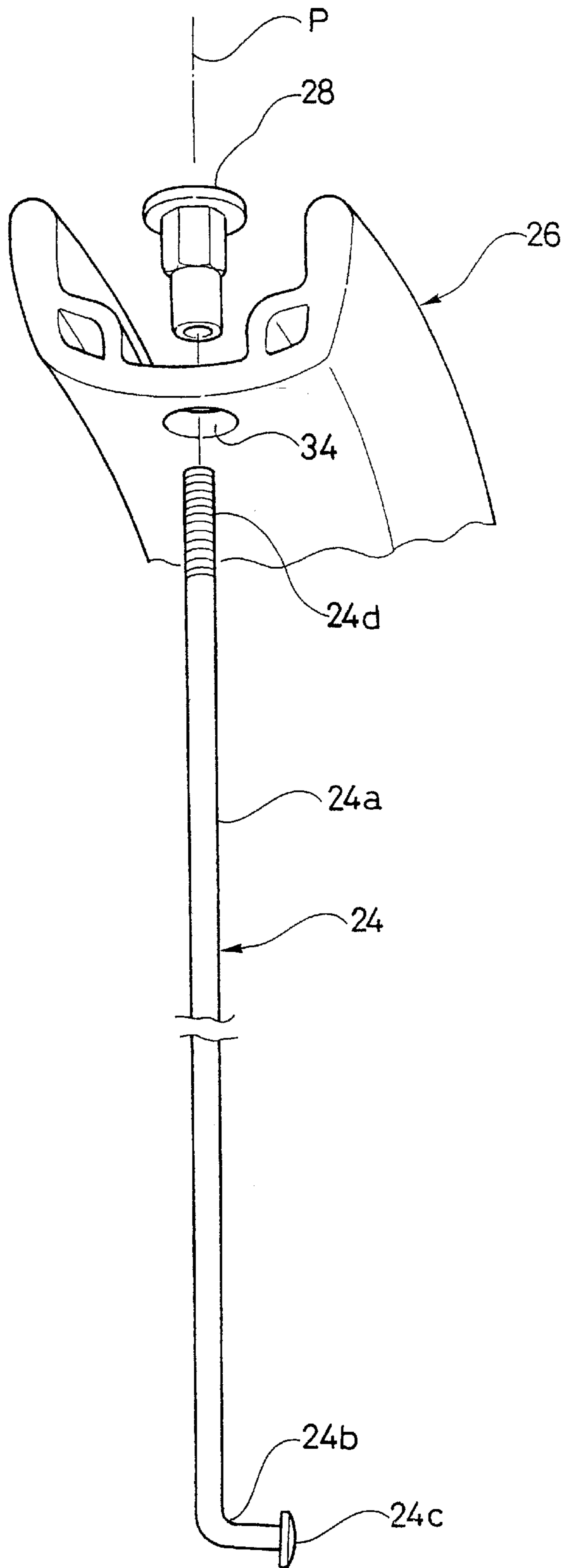


FIG. 3

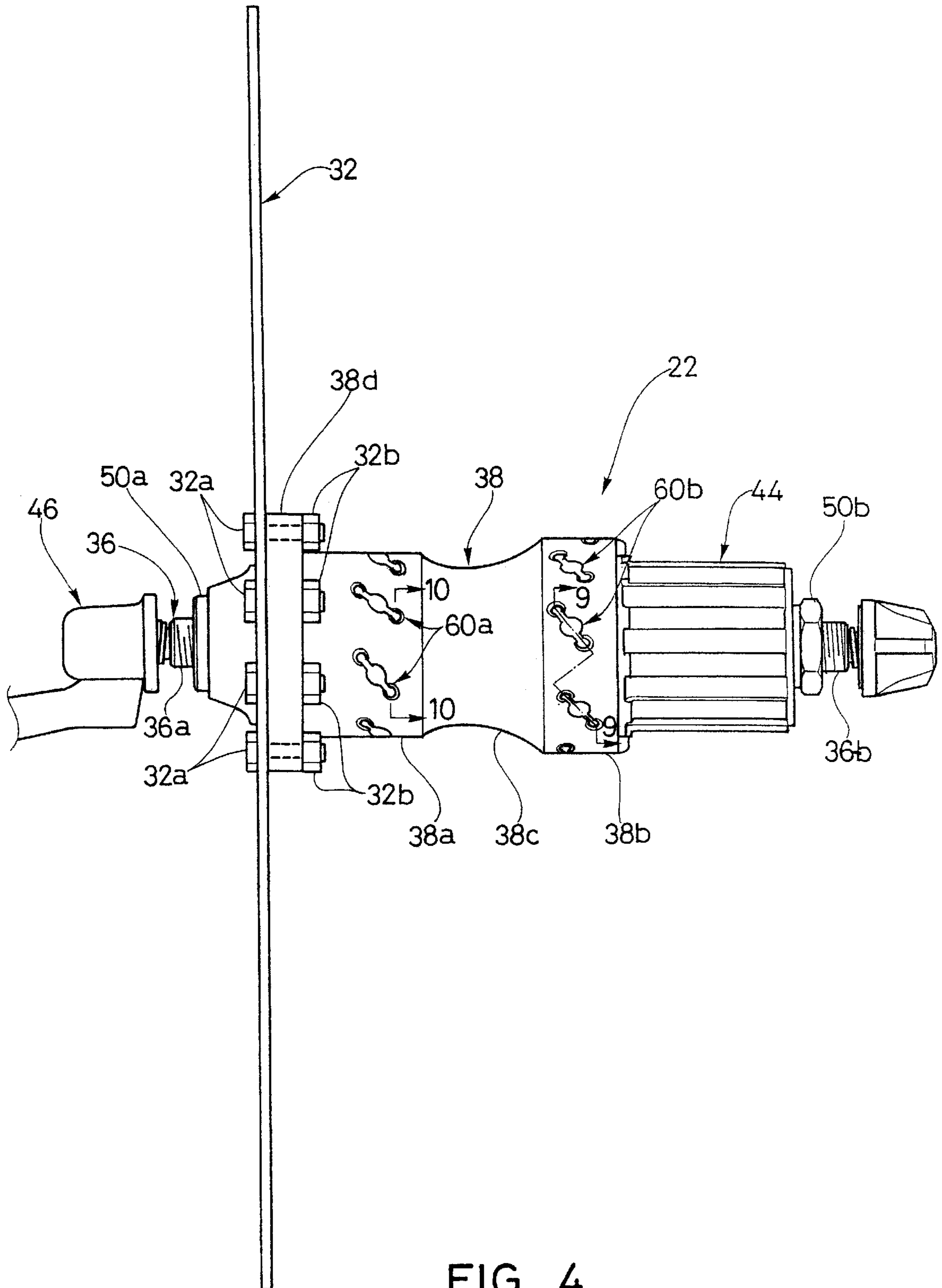


FIG. 4

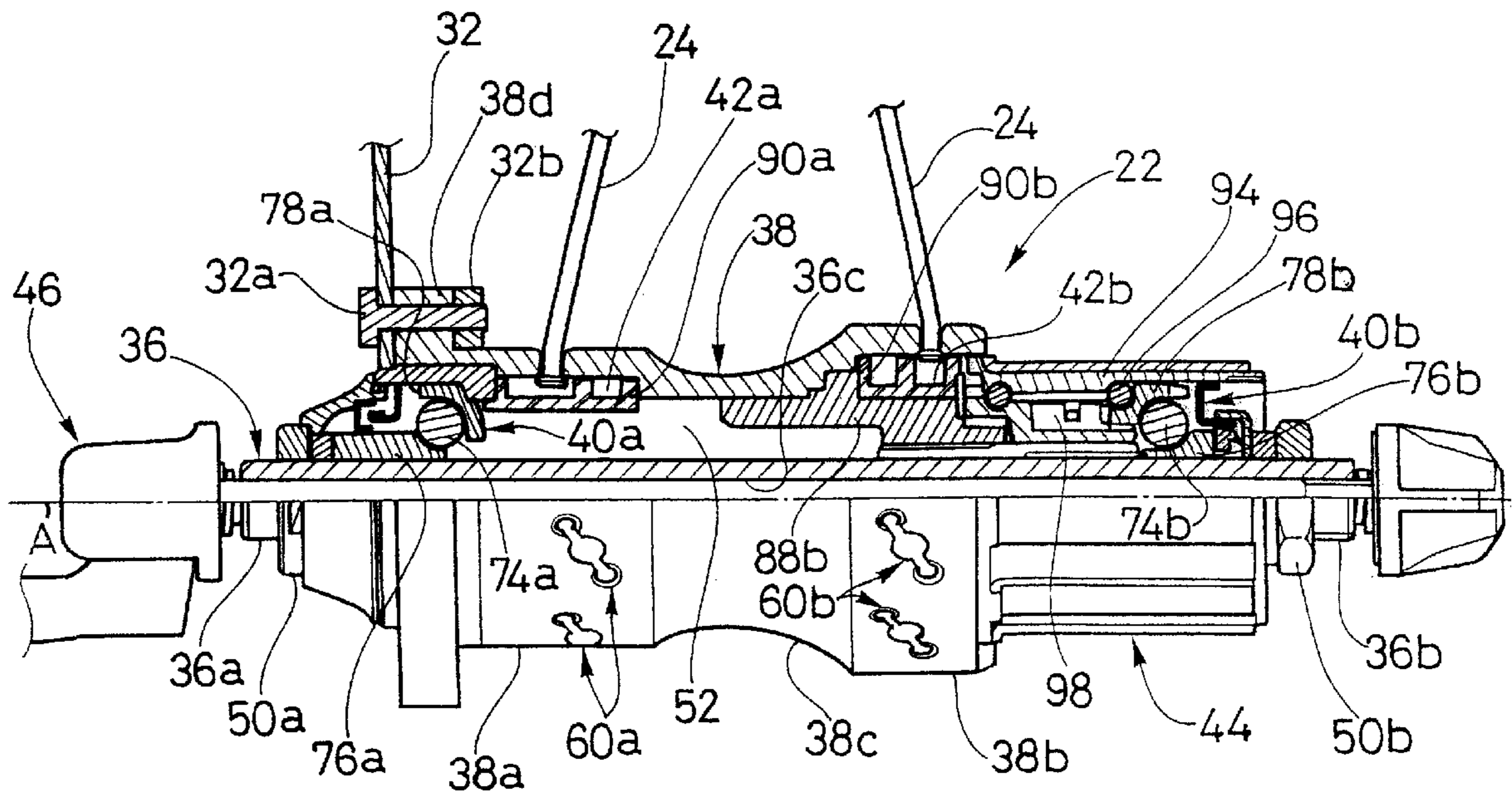


FIG. 5

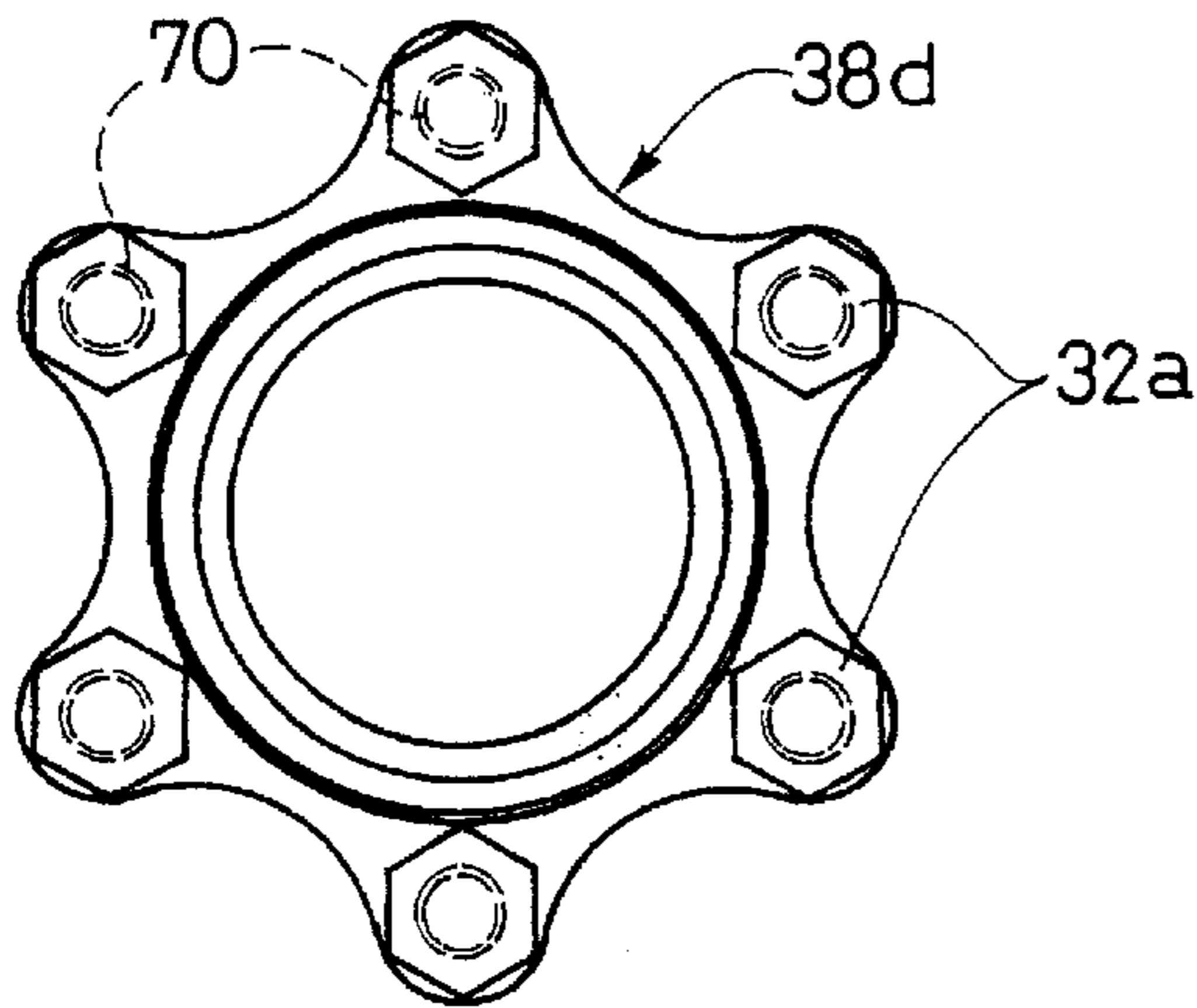


FIG. 6

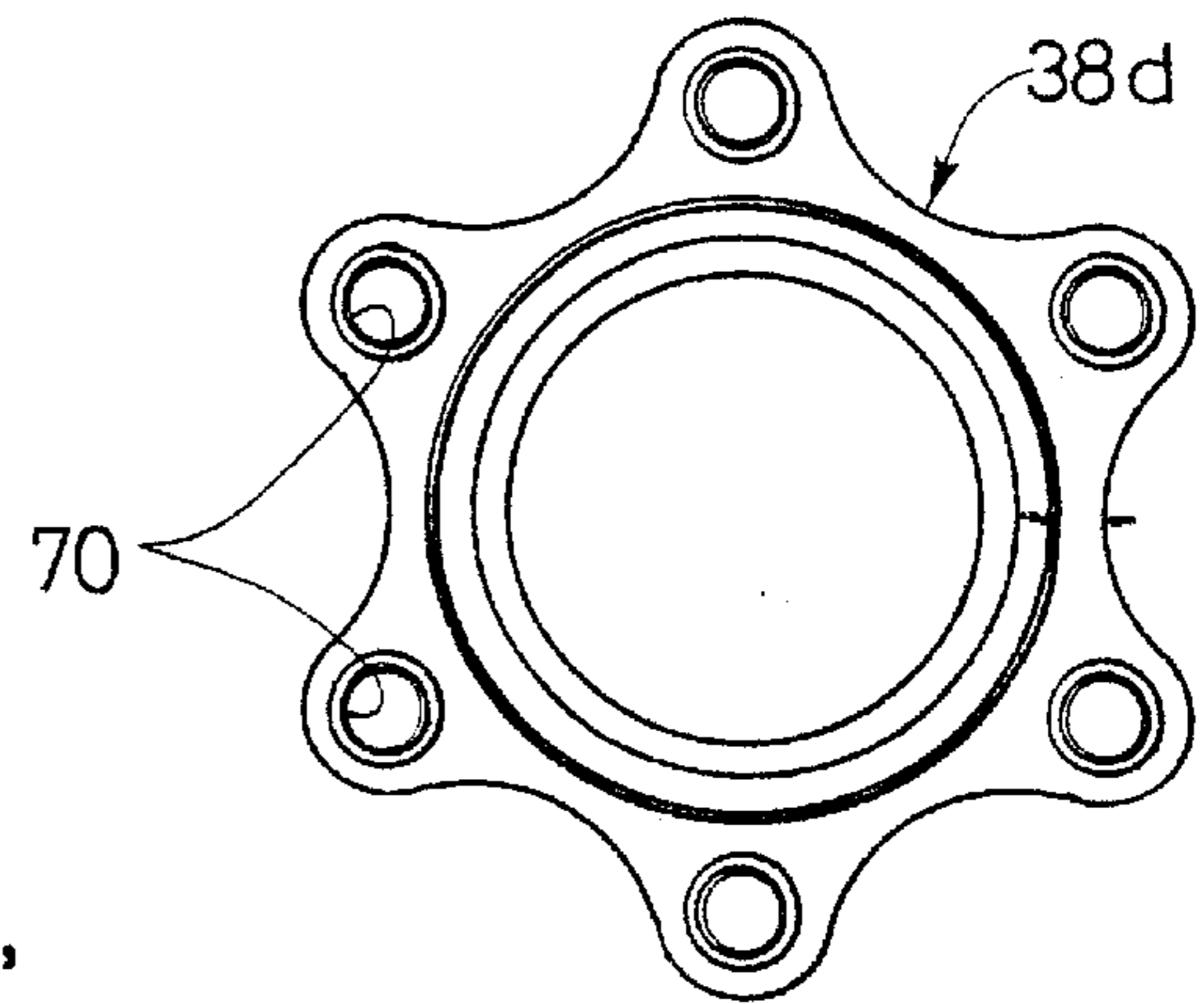


FIG. 7

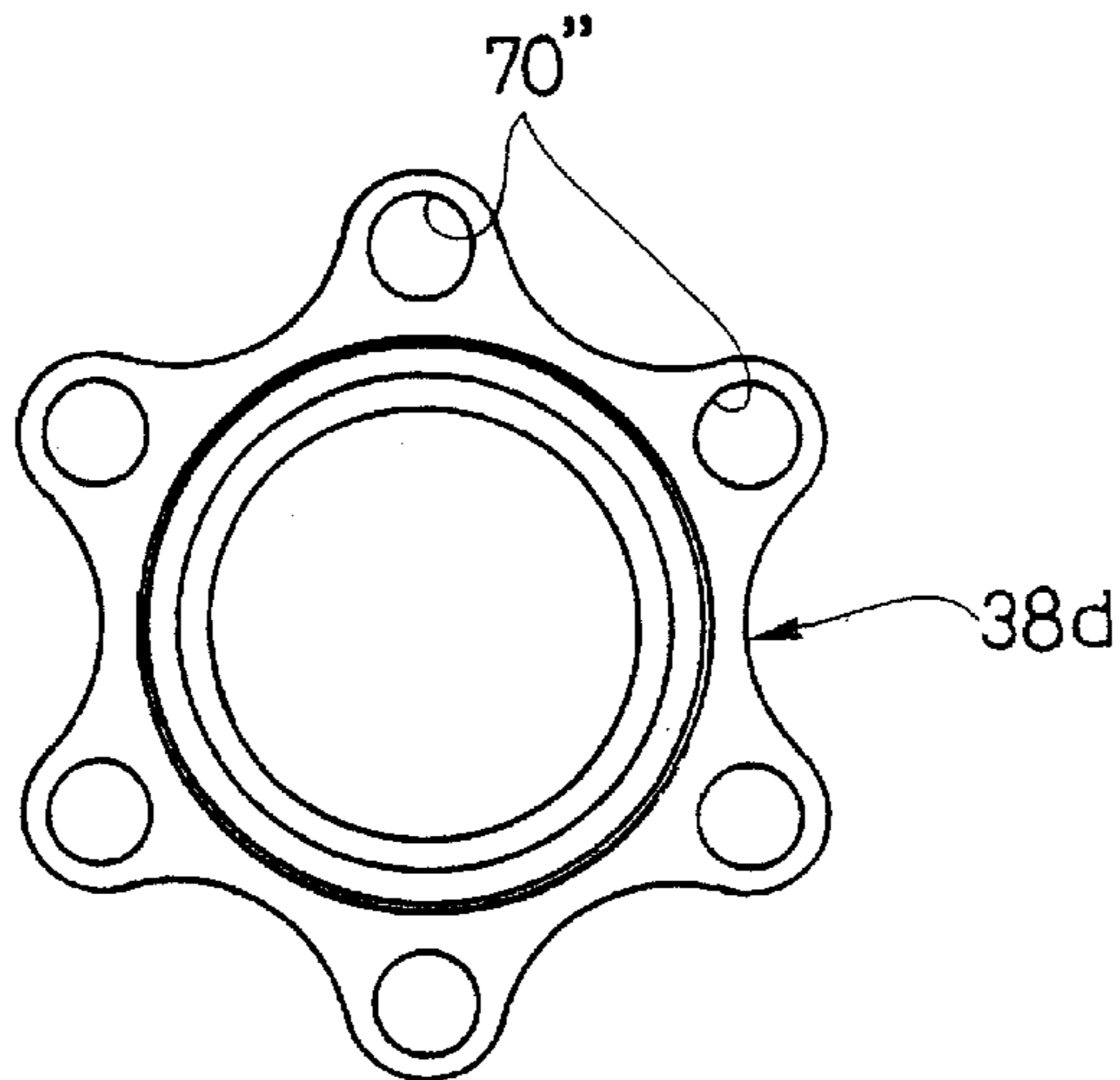
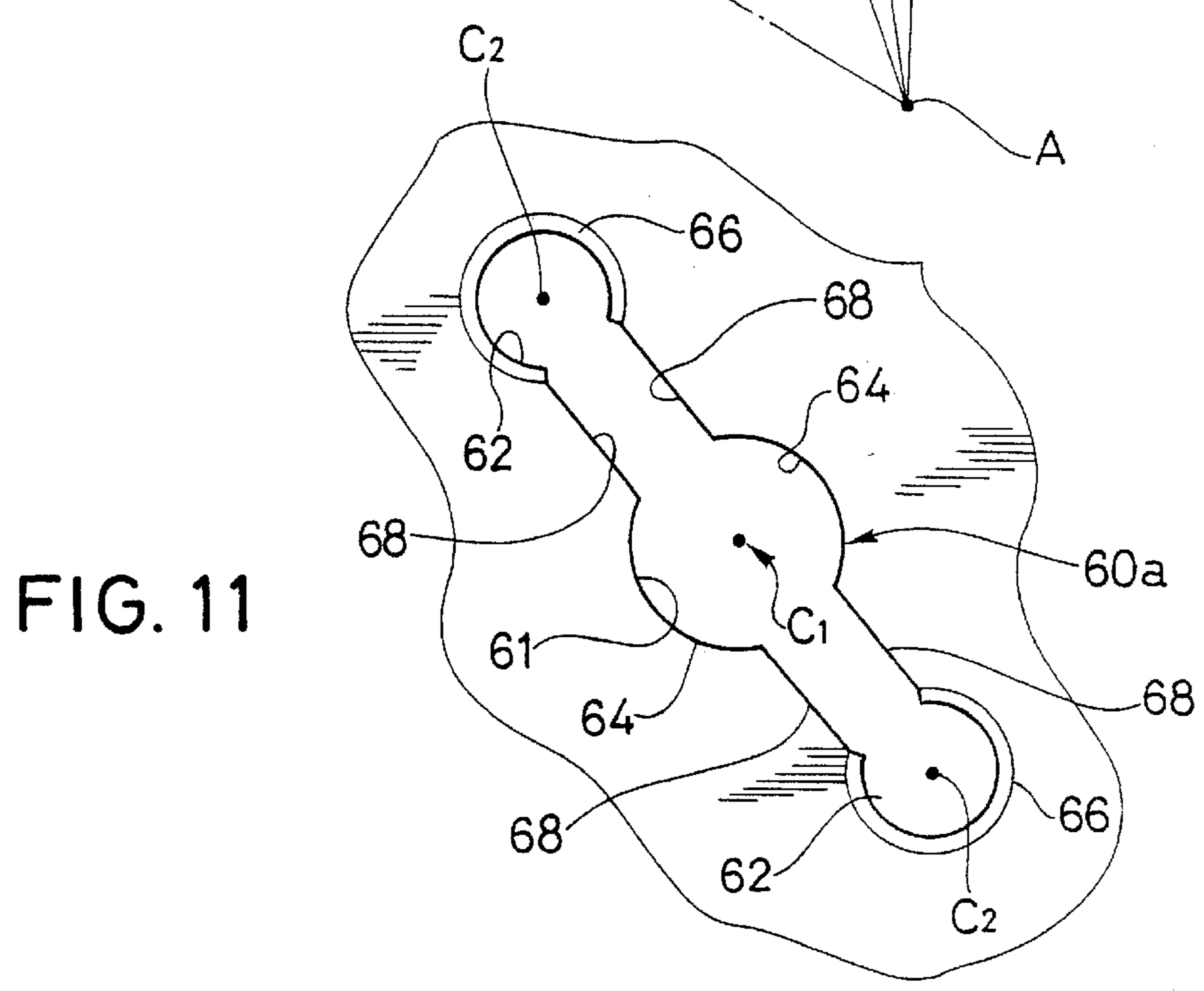
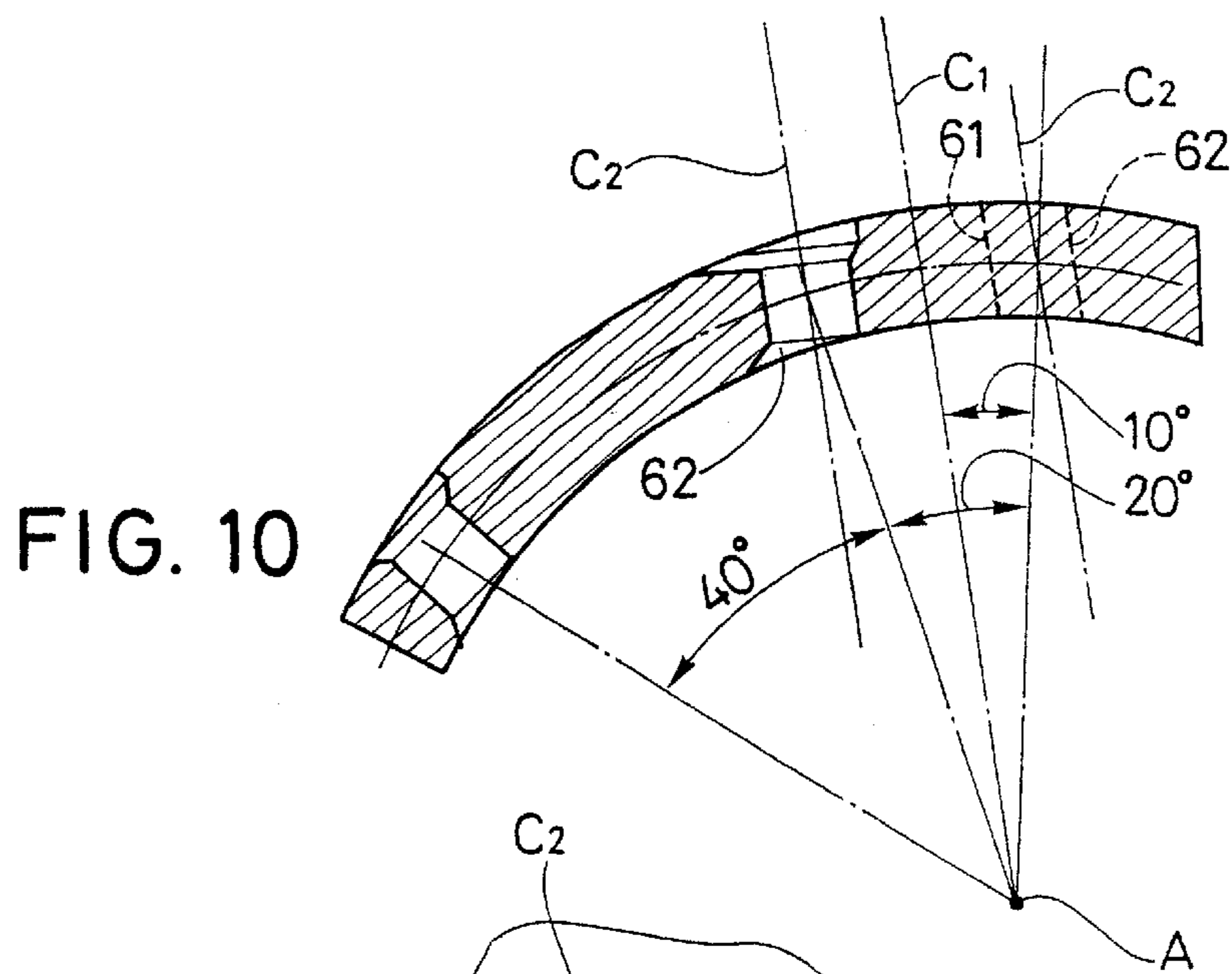
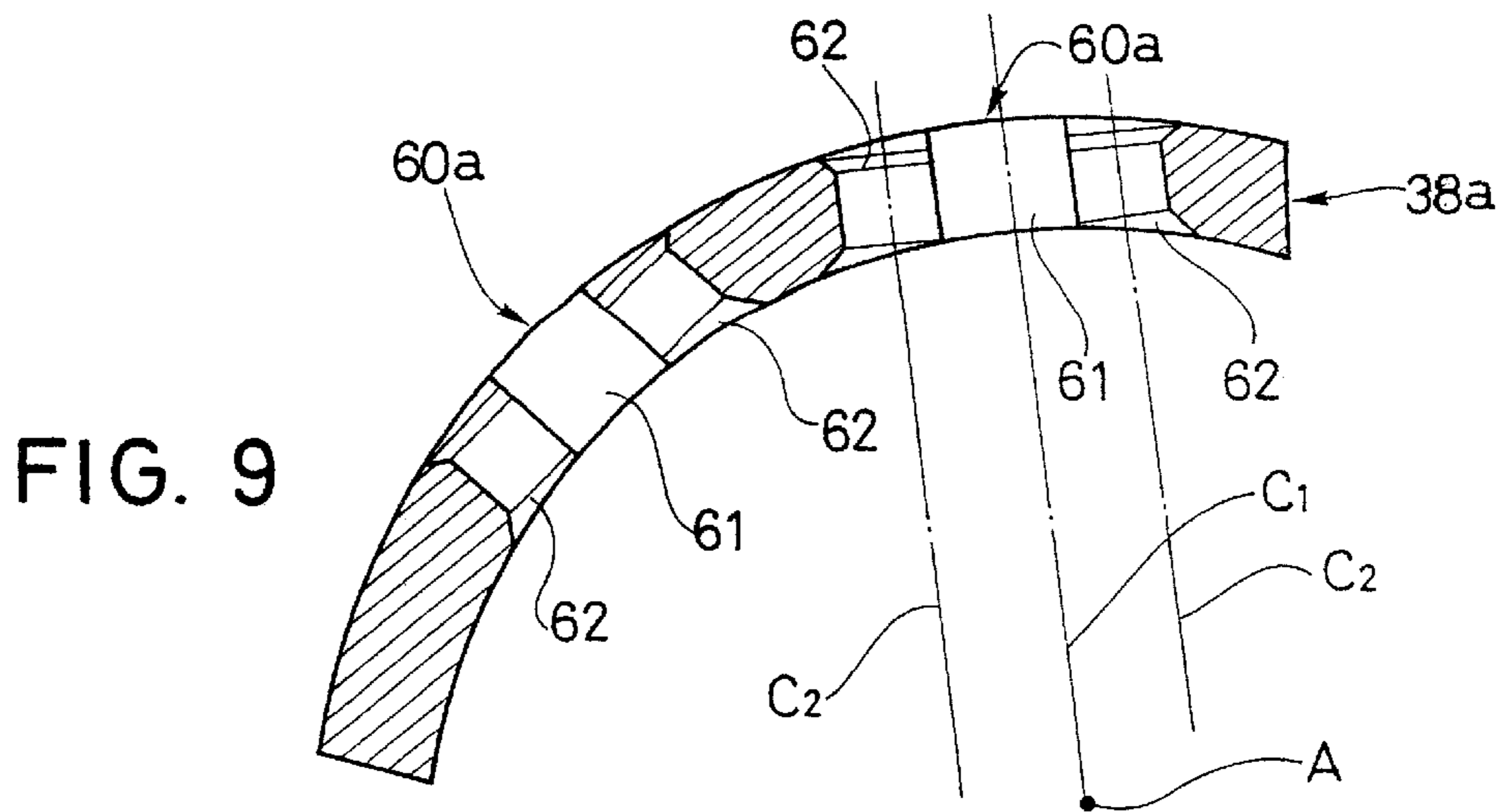


FIG. 8





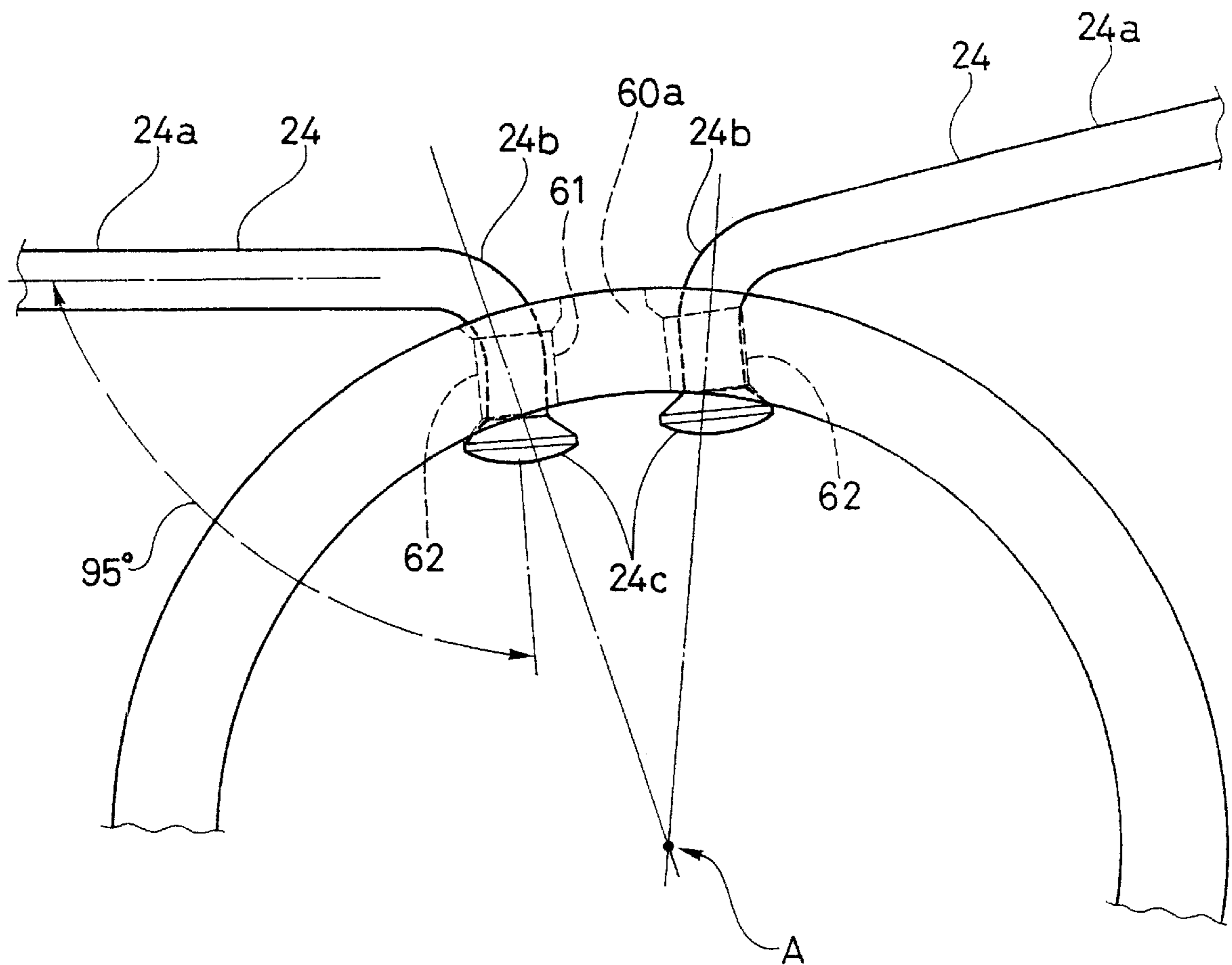


FIG. 12



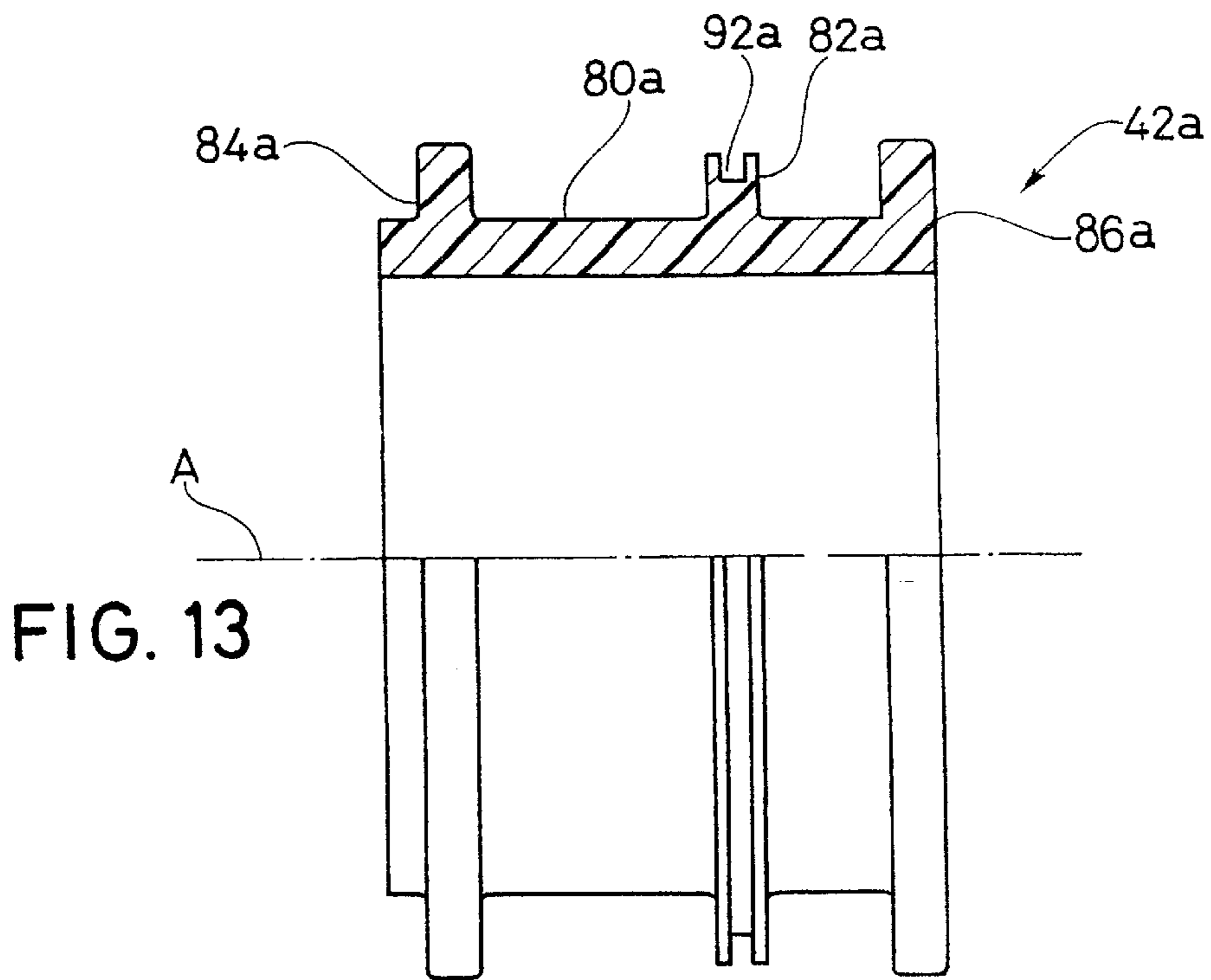


FIG. 13

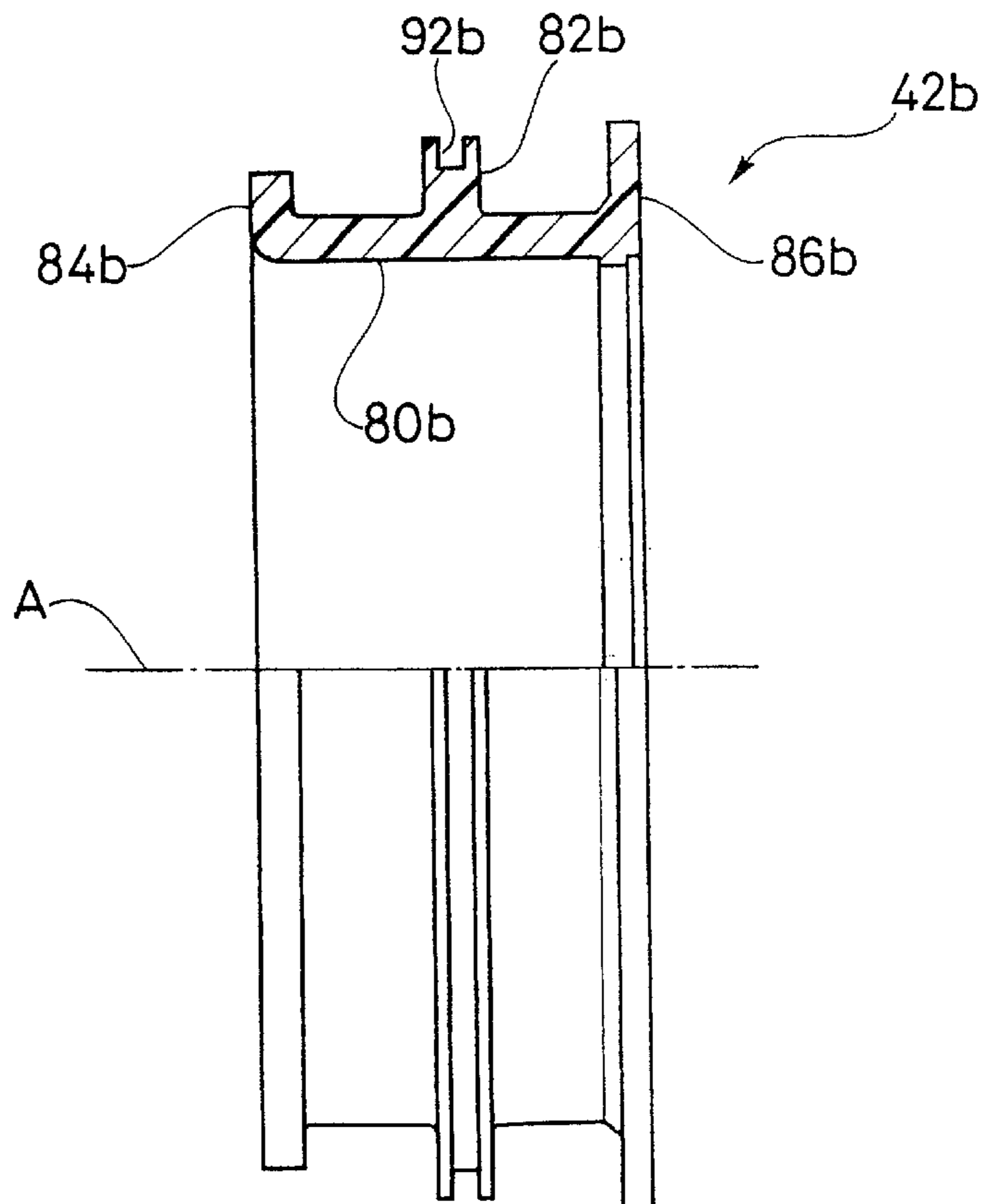


FIG. 14

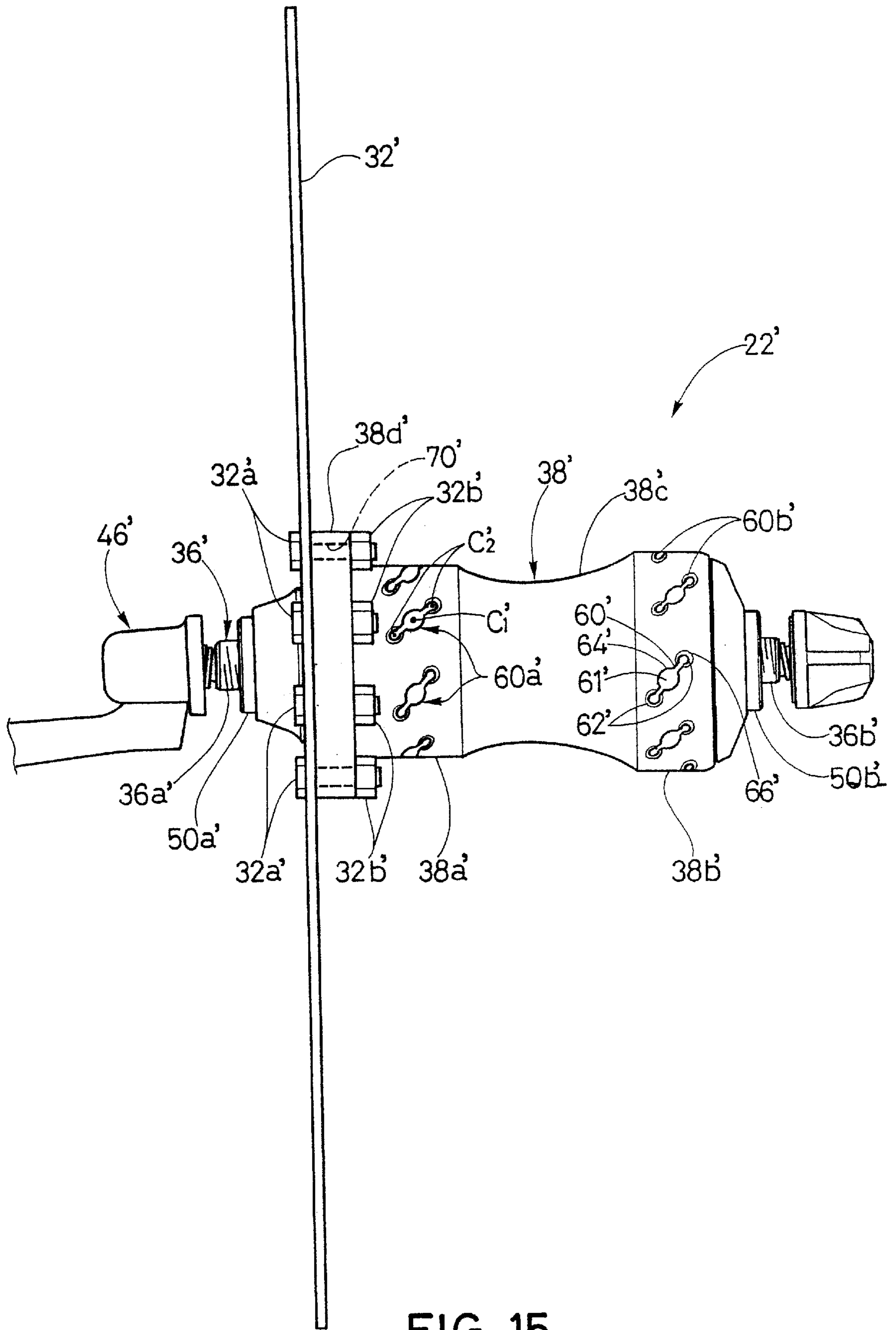
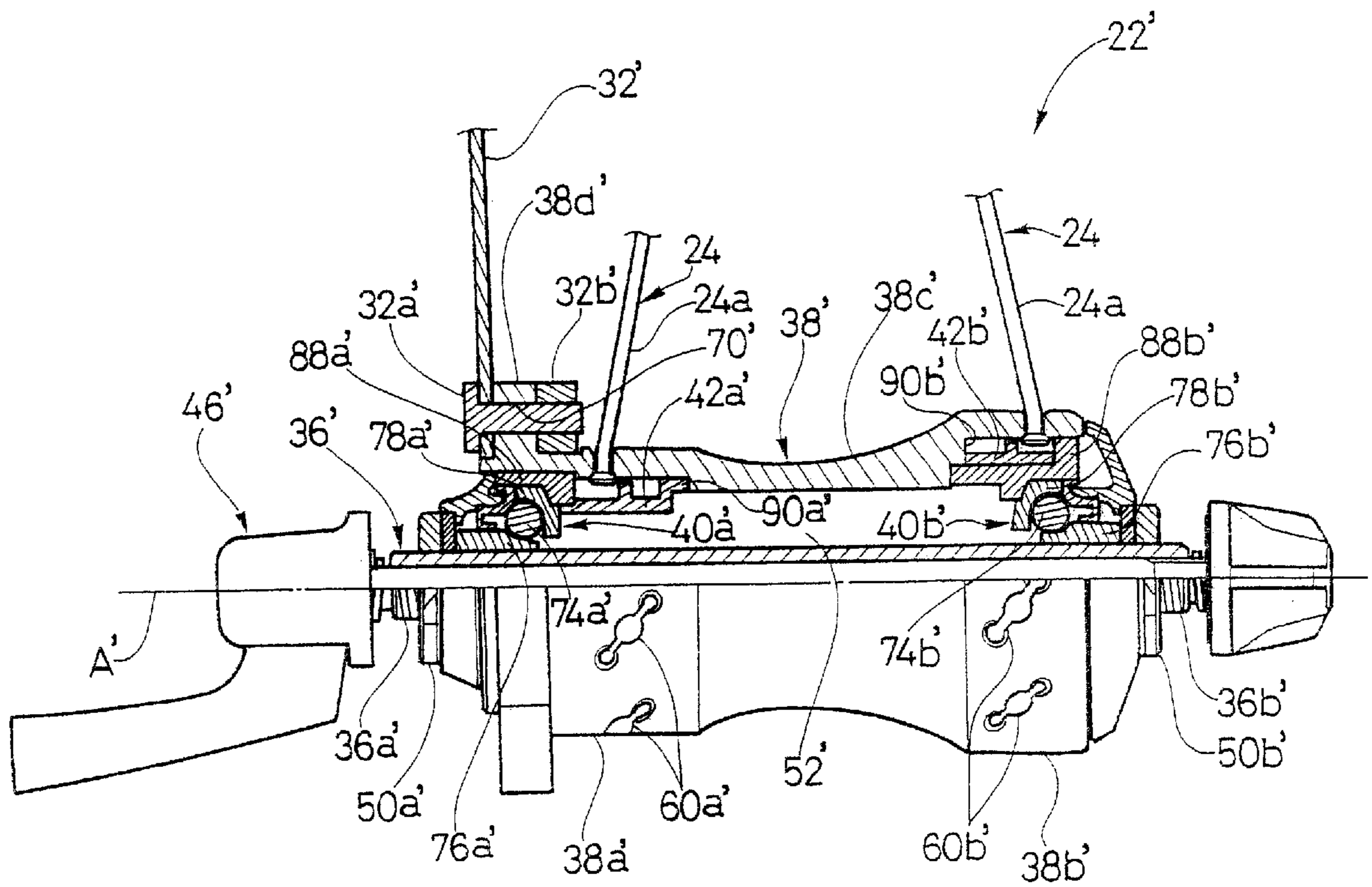


FIG. 15



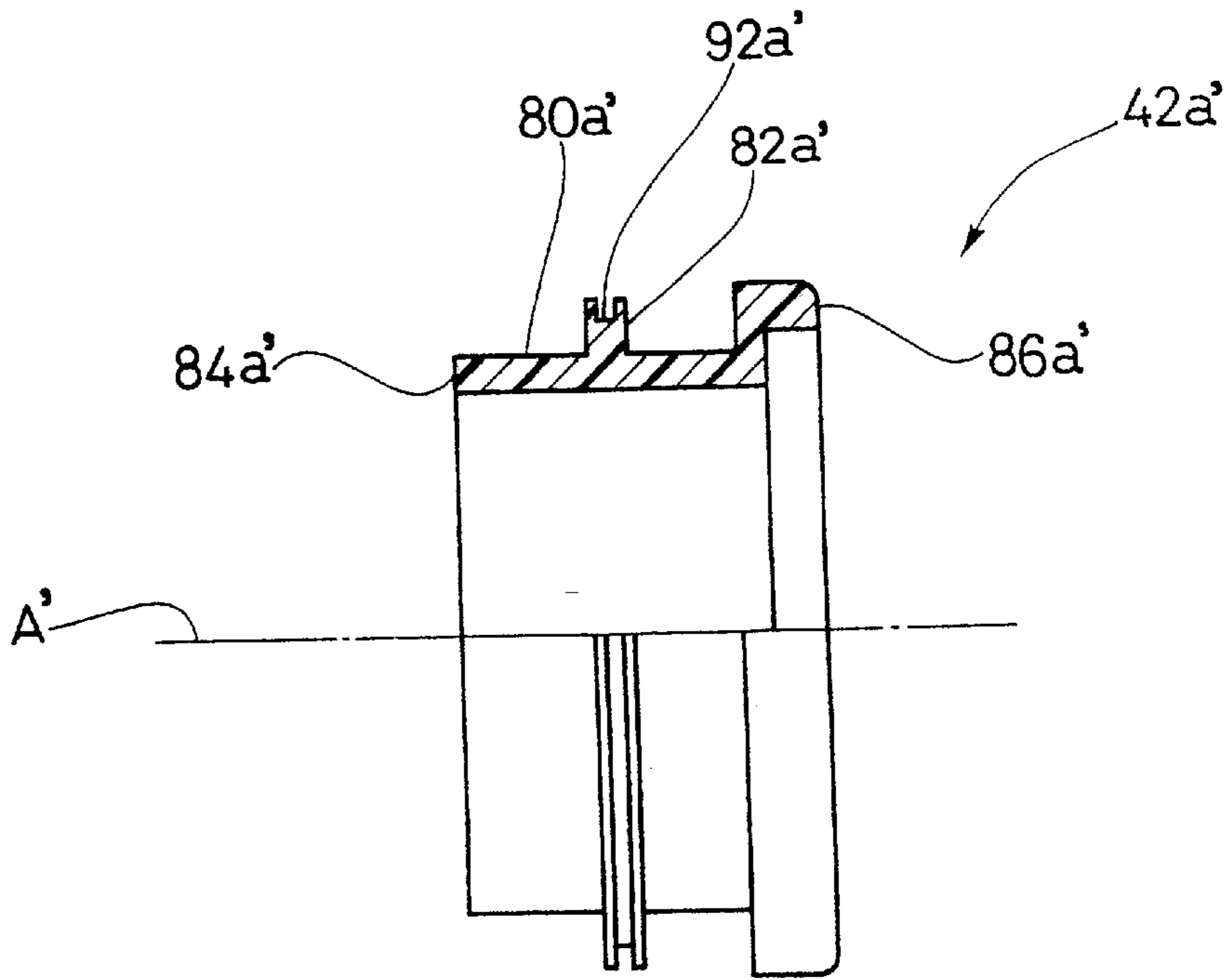


FIG. 17

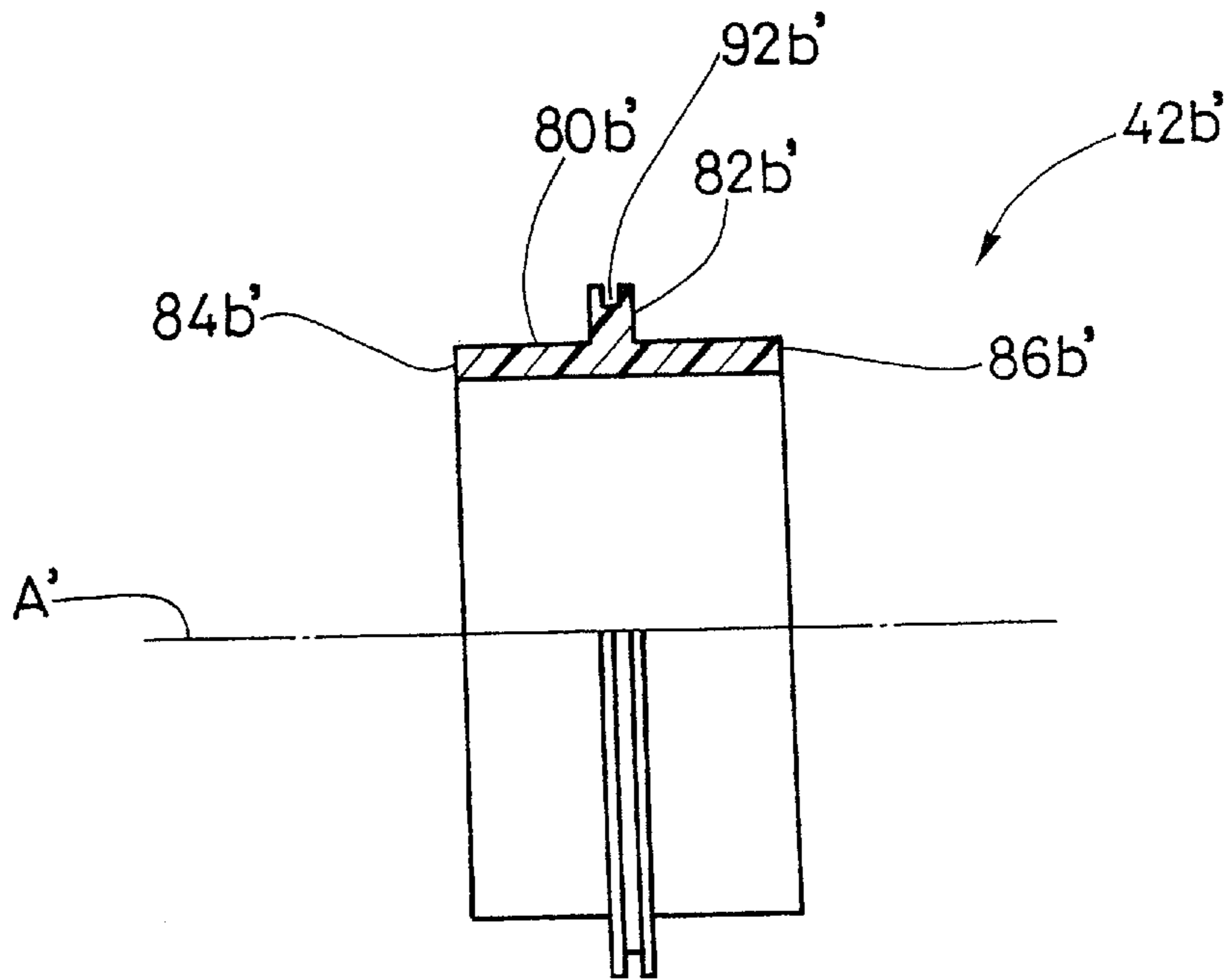


FIG. 18



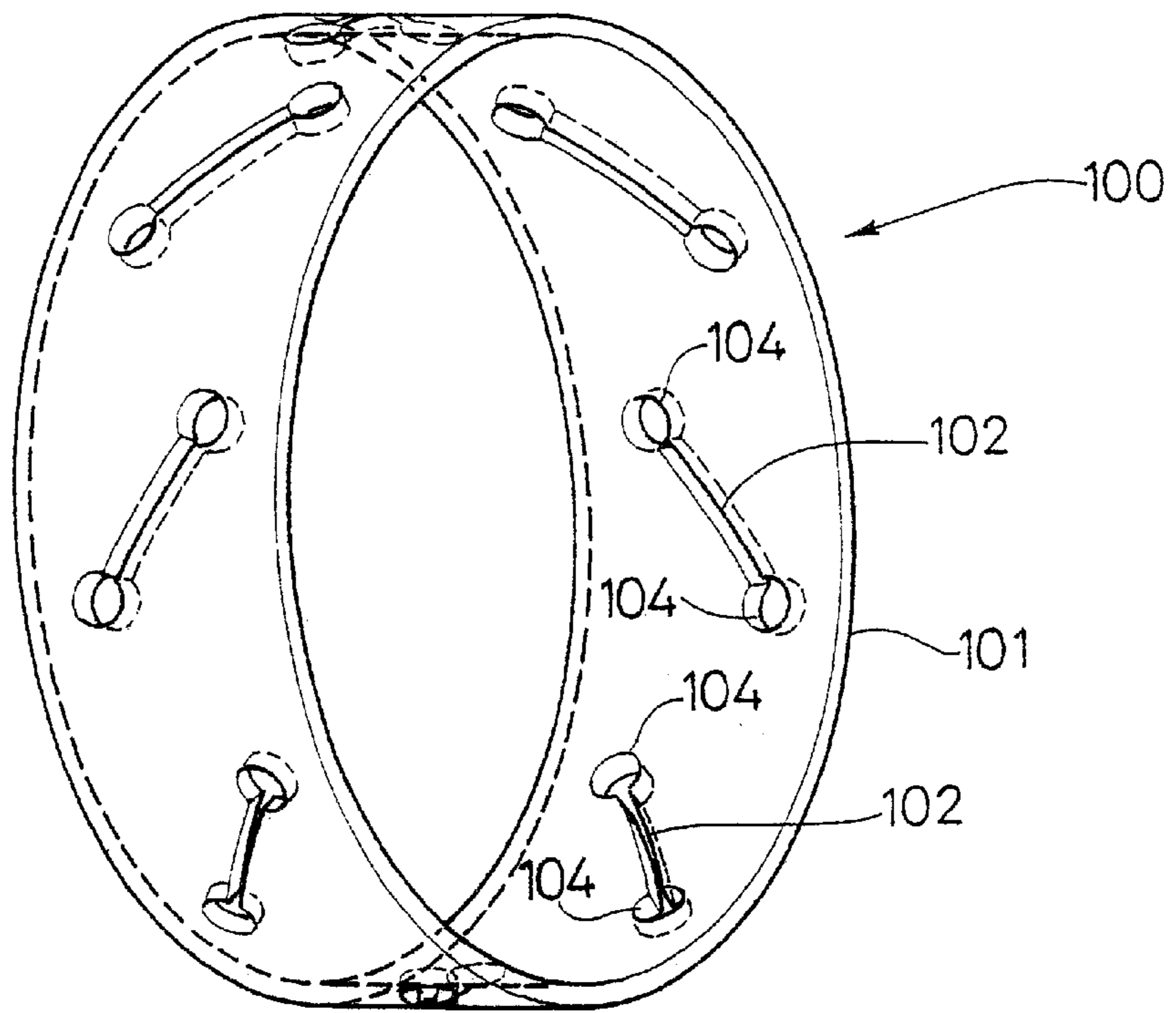


FIG. 19

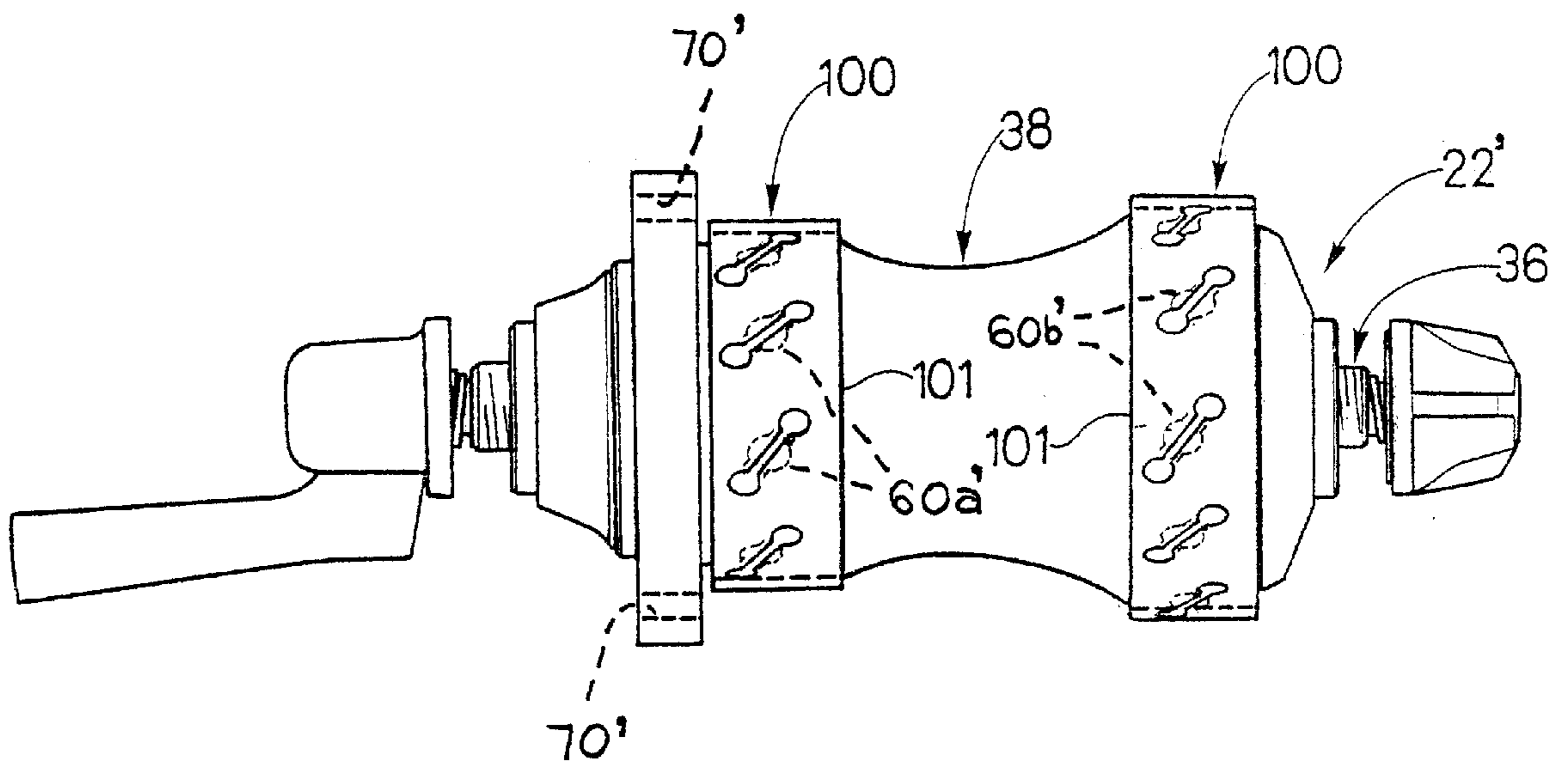


FIG. 20

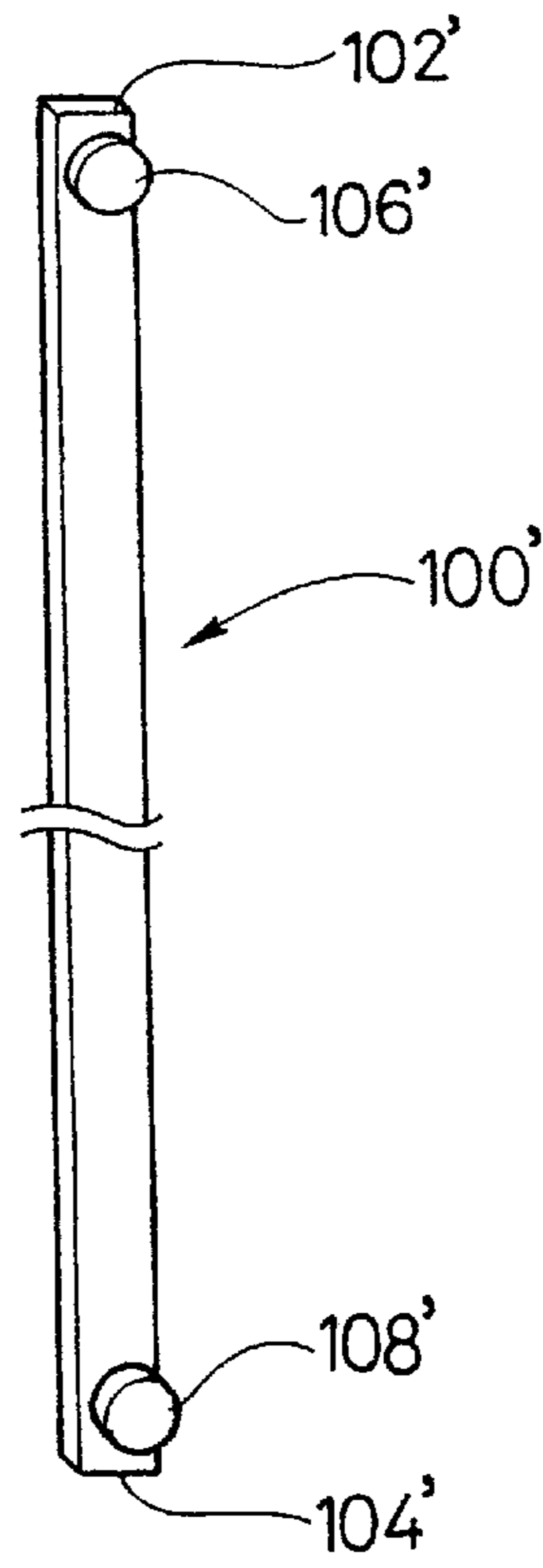


FIG. 21

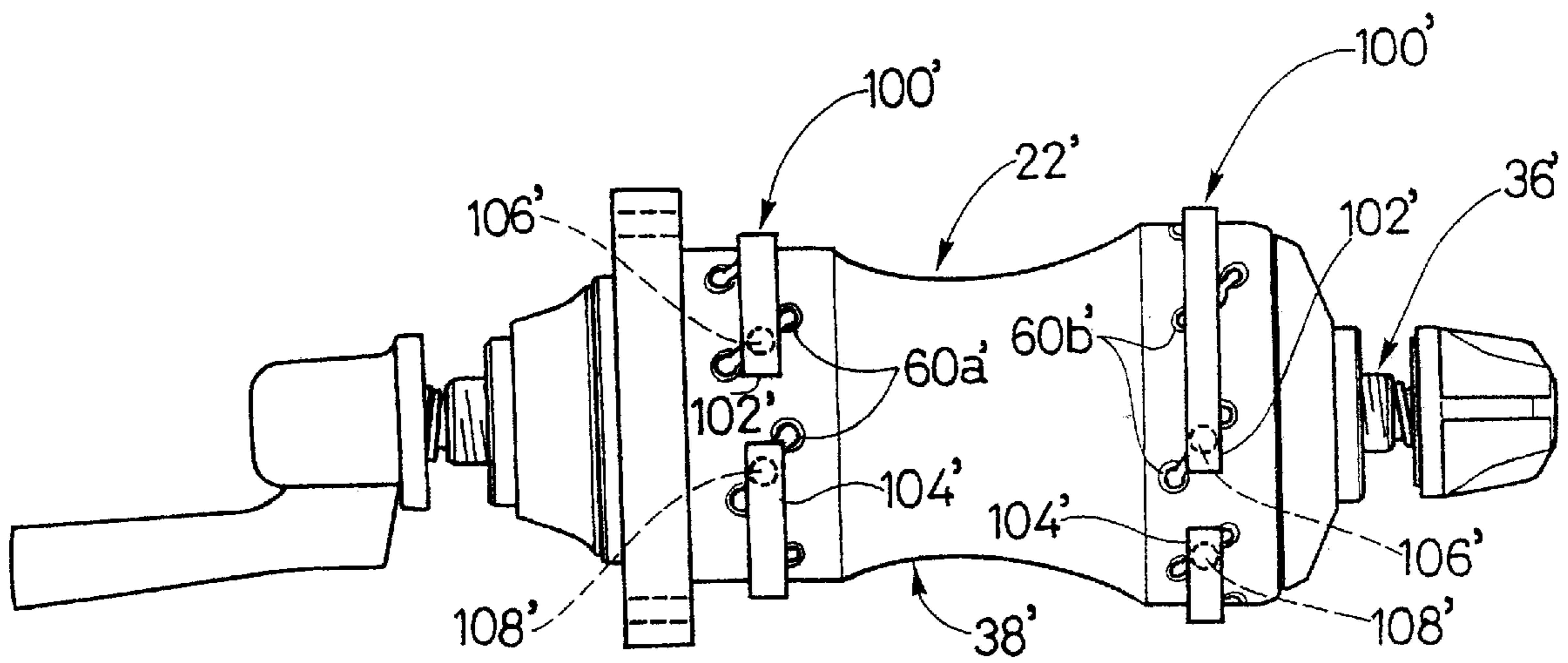


FIG. 22

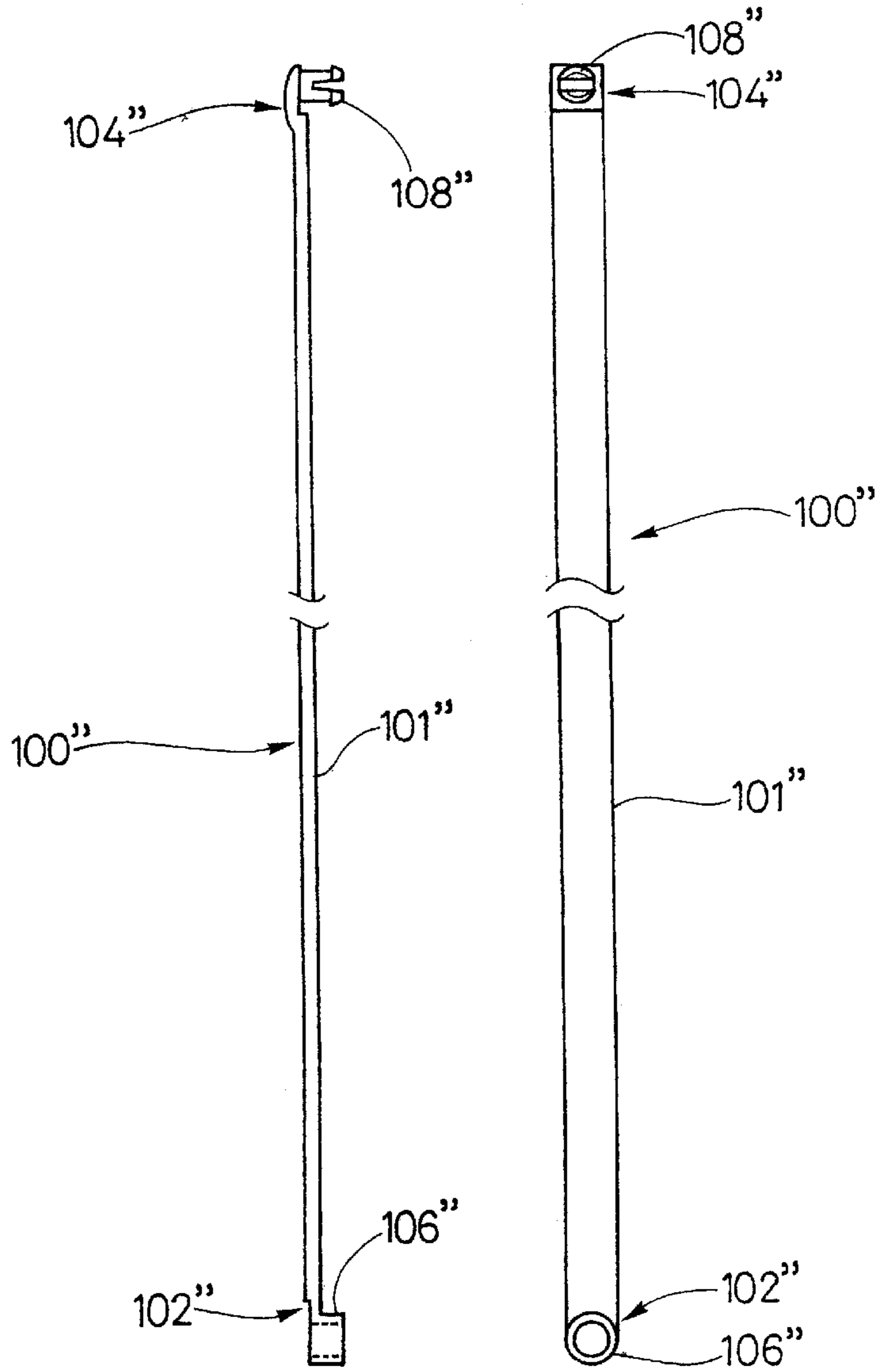


FIG. 23 FIG. 24

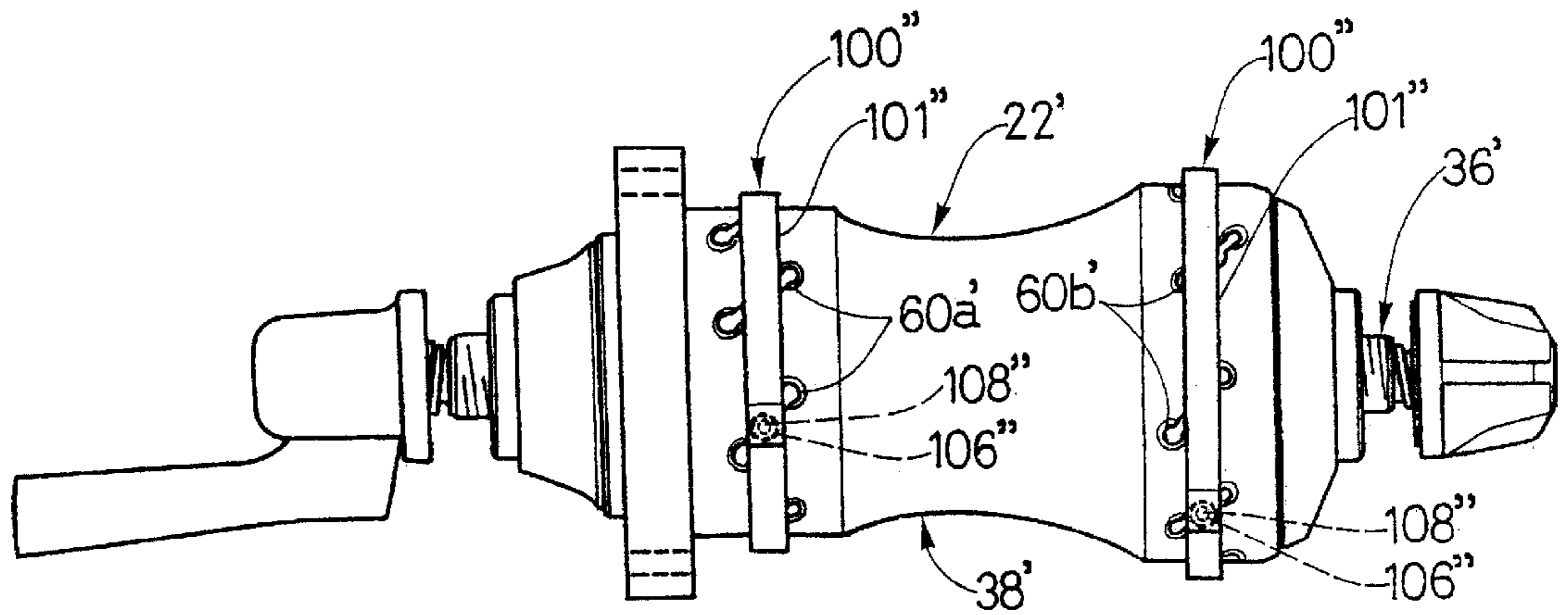


FIG. 25

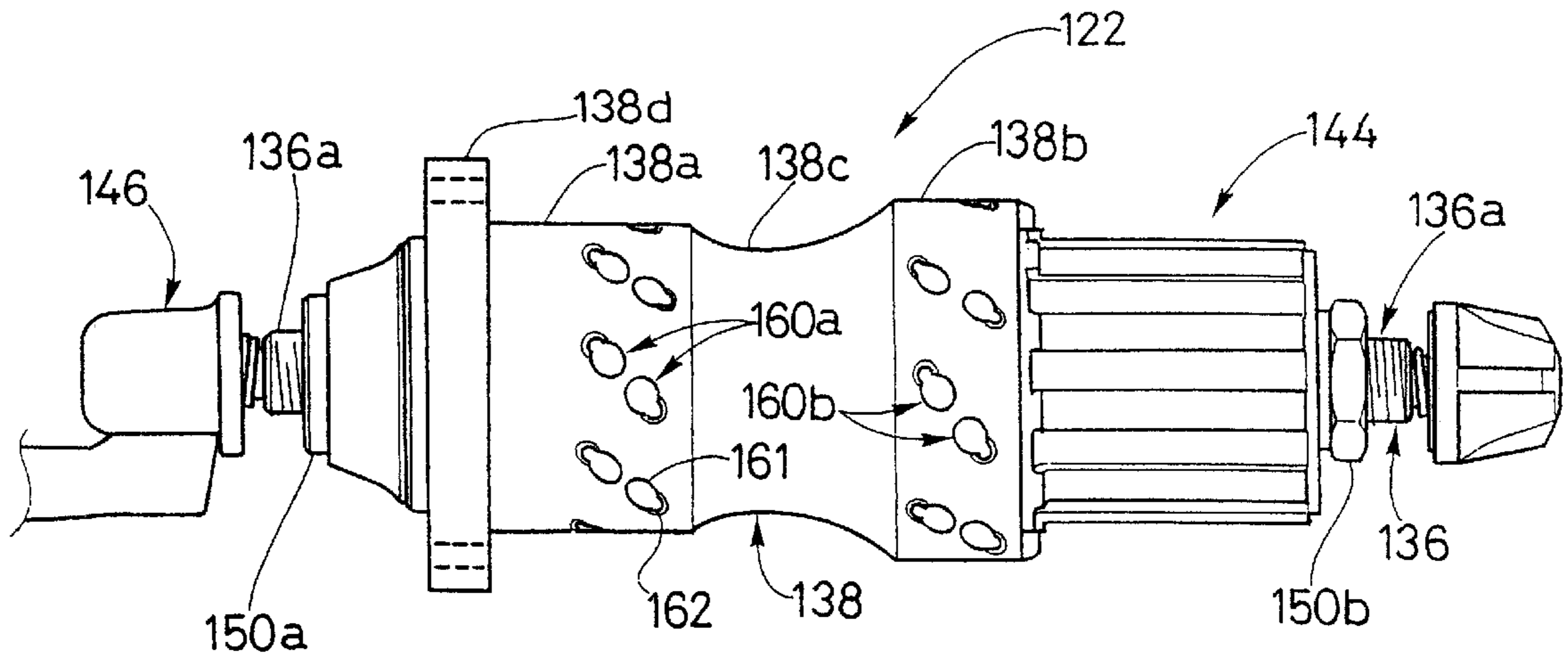


FIG. 26

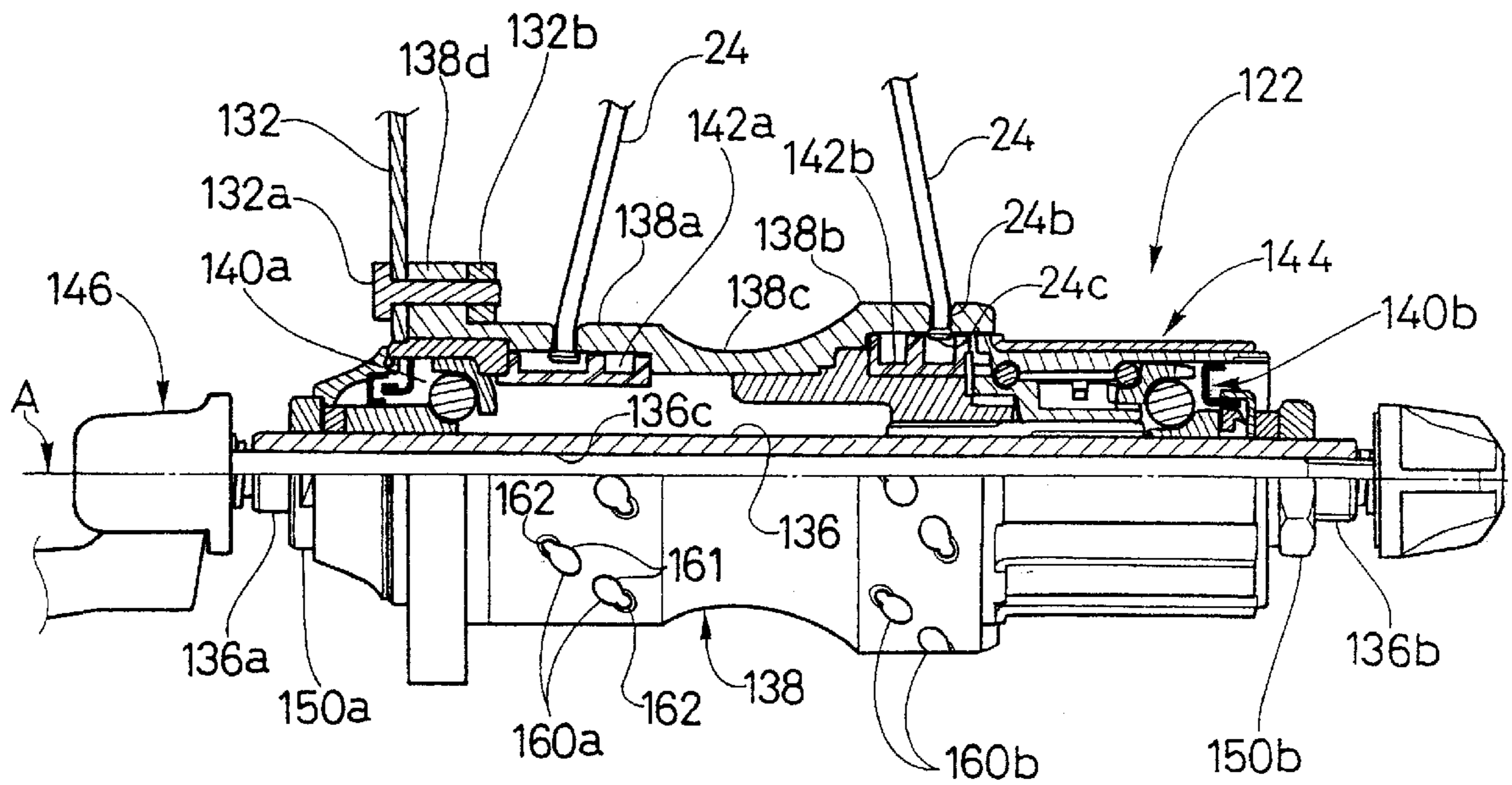


FIG. 27



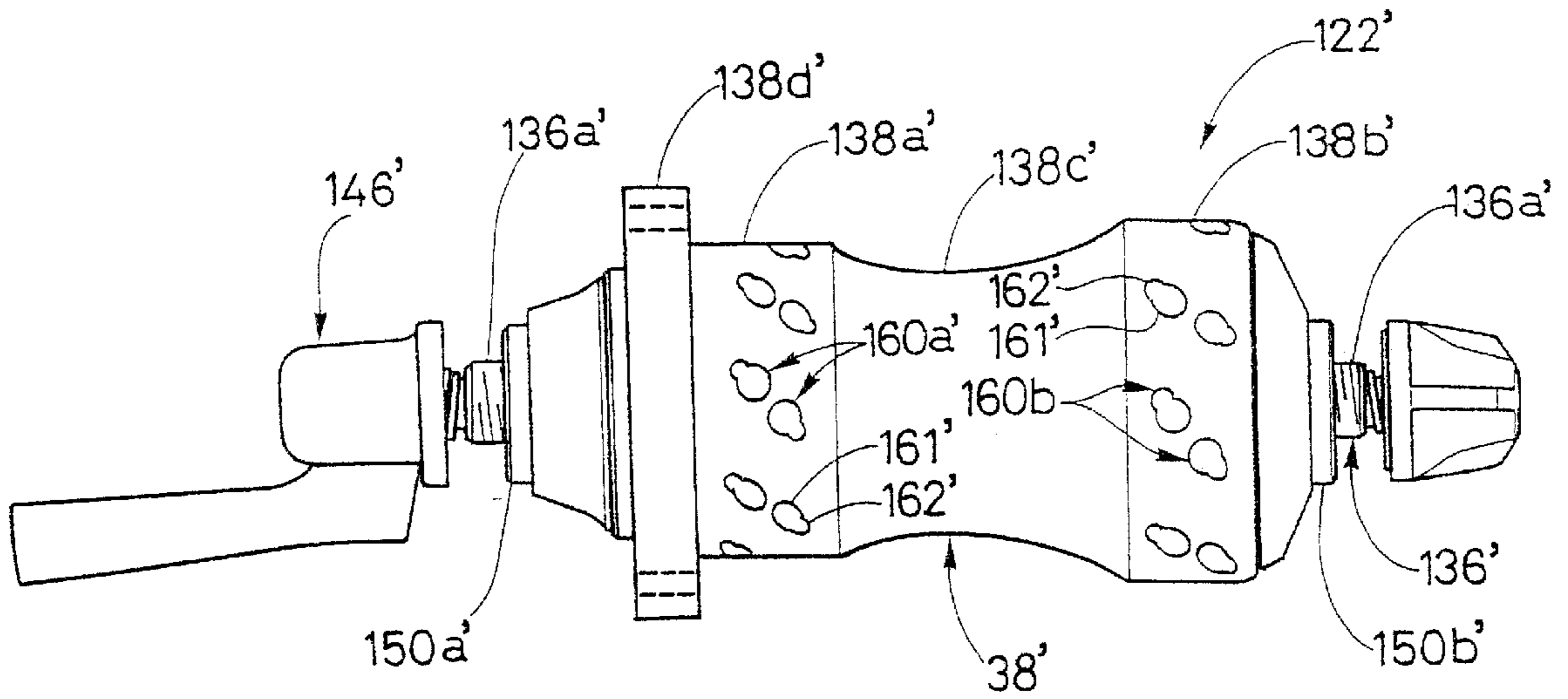


FIG. 28

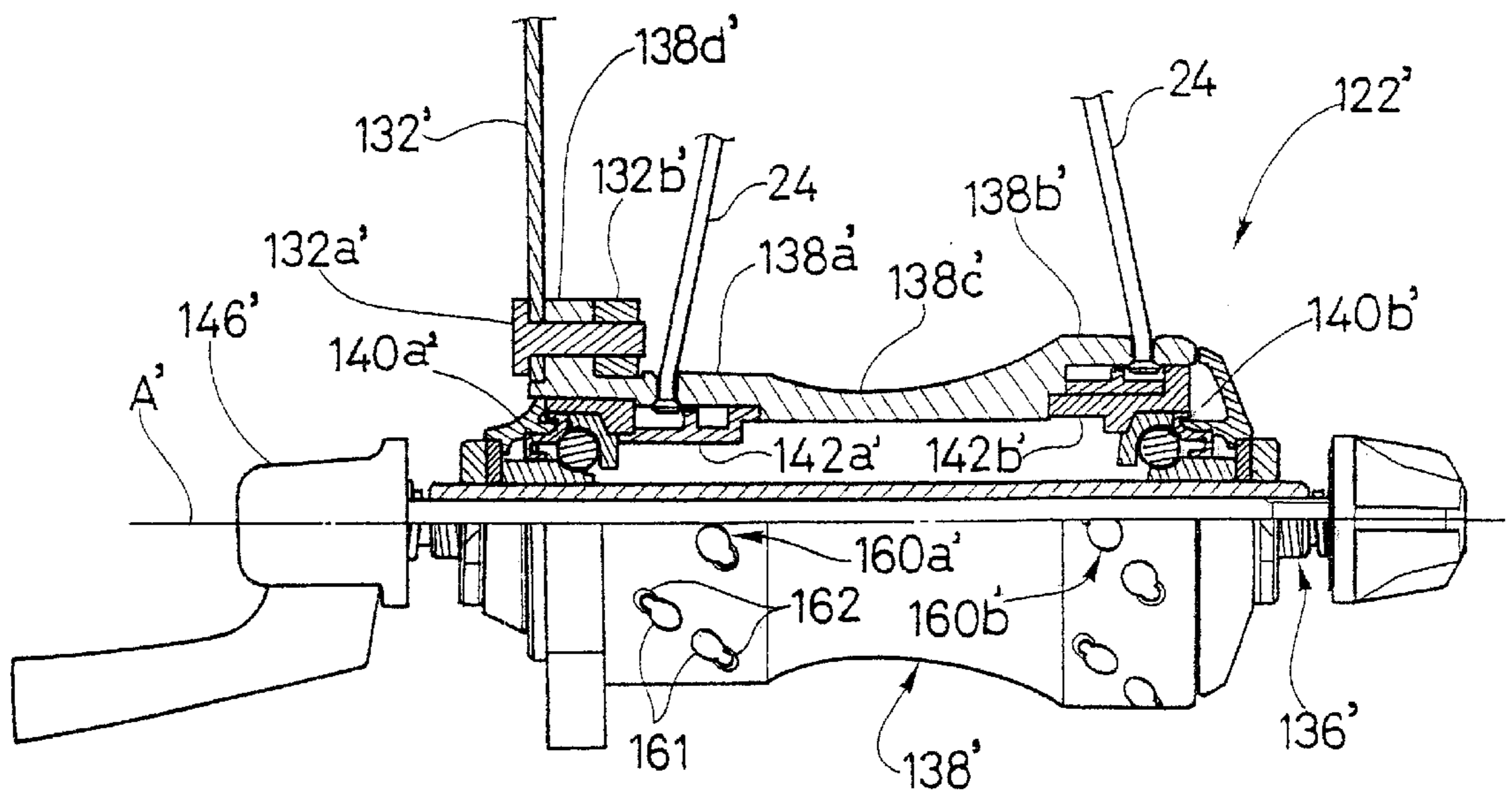


FIG. 29

**BICYCLE HUB WITH SPOKE SEAL****BACKGROUND OF THE INVENTION****1. Field of the Invention**

This invention generally relates to a bicycle hub with spoke openings in the tubular portion of the hub body. More specifically, the present invention relates a seal for a bicycle hub that isolates the spoke openings from the remainder of the interior of the hub body.

**2. Background Information**

Bicycling is becoming an increasingly popular form of recreation as well as a means of transportation. Moreover, bicycling has become a very popular competitive sport. Whether the bicycle is used for recreation, transportation or competition, the bicycle industry is constantly improving their components. Recently, the braking systems for bicycles have included the use of disc brakes. The use of disc brakes has resulted in modifications to the bicycle hub of the bicycle wheel so that a brake rotor can be mounted thereon.

The most basic bicycle wheels have a hub, a plurality of spokes and an annular rim. The hub is attached to a part of the frame of the bicycle for relative rotation. The inner ends of the spokes are coupled to the hub and extend outwardly from the hub. The annular rim is coupled to the outer ends of the spokes and has an outer portion for supporting a pneumatic tire thereon. Typically, the spokes of the bicycle wheel are thin metal wire spokes. The ends of the hub are provided with a flange that is used to couple the spokes to the hub. In particular, holes are provided in the hub flanges. The wire spokes are usually bent on their inner end and provided with an enlarged head or flange that is formed in the shape of a nail head. The inner end is supported in one of the holes in one of the hub flanges. The outer ends of the spokes typically are provided with threads for engaging spoke nipples, which secure the outer ends of the wire spokes to the rim. In particular, the spoke nipples have flanges, which engage the interior surface of the rim.

With a spoke constructed in this manner, the nipples are installed in nipple holes formed in the rim. The spokes are inserted sideways through the holes in the hub flange until the enlarged head or flanges of the spokes engaging the areas surrounding the holes in the hub flange. The male threads on the ends of the spokes are threaded into the female threads of the spoke nipples installed in the openings of the rim.

When the hub is a brake disc hub or is a rear hub, installation and/or replacement of the spokes can be difficult. In the case of a disk brake hub, one end of the hub usually has a rotor mounting portion. Often, the rotor mounting portion is a plurality of blind bores that receive bolts to directly mount the brake disc rotor to the end of the hub. Thus, the brake disc rotor makes it difficult to insert the spokes in a sideways direction. Likewise, if the hub is a rear hub, the sprockets can be obstacles to install or replace spokes.

One problem with spoke openings in the tubular portion of the hub body is that contaminants can enter the hub body through the spoke openings. When dirt gets into the hub body, the rotation of the hub body relative to the hub axle can be significantly impair.

In view of the above, there exists a need for a spoke seal for a bicycle hub which overcomes the above mentioned problems in the prior art. This invention addresses this need in the prior art as well as other needs, which will become apparent to those skilled in the art from this disclosure.

**SUMMARY OF THE INVENTION**

One object of the present invention is to provide a bicycle hub with a seal for isolating the spoke openings from the interior of the hub body.

Another object of the present invention is to provide a bicycle hub with a seal that aids in the installation of the spokes.

Another object of the present invention is to provide a bicycle hub that can use conventional tangential spokes that are attached directly to the tubular body portion of the hub body.

Another object of the present invention is to provide a bicycle hub that is relatively lightweight in that no spoke flanges are needed.

The foregoing objects can be attained by providing a bicycle hub for use with bicycle spokes. The bicycle hub comprising a hub axle, a hub body and a seal arranged in the hub body. The hub axle has a center axis extending between a first end and a second end. The hub body has an interior passageway with the hub axle being rotatably supported therein. The hub body has a set of first spoke openings circumferentially arranged around the hub body. The seal is arranged in the interior passageway of the hub body and adjacent the first spoke openings to isolate the first spoke openings from the hub axle.

The foregoing objects can further be attained by providing a bicycle hub for use with bicycle spokes. The bicycle hub comprising a hub axle, a hub body and a seal arranged in the hub body. The hub axle has a center axis extending between a first end and a second end. The hub body has an interior passageway with the hub axle being rotatably supported therein. The hub body has a set of first spoke openings circumferentially arranged around the hub body. The seal is arranged in the interior passageway of the hub body to form a first isolated space of the interior passageway below the first spoke openings.

These and other objects, features, aspects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Referring now to the attached drawings which form a part of this original disclosure:

FIG. 1 is a side elevational view of a conventional bicycle with front and rear brake disc hubs in accordance with a first embodiment of the present invention;

FIG. 2 is a side elevational view of the rear wheel of the bicycle illustrated in FIG. 1 with the sprockets removed;

FIG. 3 is partially exploded perspective view of the rim, one of the spokes and one of the spoke nipples of the bicycle illustrated in FIG. 1;

FIG. 4 is a side elevational view of the rear brake disc hub of the rear wheel illustrated in FIG. 2 with the sprockets removed;

FIG. 5 is a side elevational view of the rear brake disc hub of the rear wheel illustrated in FIG. 3 with certain portions broken away for purposes of illustration;

FIG. 6 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with the brake disc rotor bolts mounted thereto;

FIG. 7 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with the brake disc rotor bolts removed;



FIG. 8 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with unthreaded bolt holes;

FIG. 9 is a partial transverse cross-sectional view of the rear brake disc hub body illustrated FIGS. 4 and 5 as seen along section line 9—9 of FIG. 4;

FIG. 10 is a partial transverse cross-sectional view of the rear brake disc hub body illustrated FIGS. 4 and 5 as seen along section line 10—10 of FIG. 4;

FIG. 11 is a partial elevational view of one of the spoke openings of the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 12 is a schematic view of portion of the rear brake disc hub body illustrated in FIGS. 4 and 5 with two spokes extending outwardly therefrom;

FIG. 13 is a partial cross-sectional view of the first seal for the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 14 is a partial cross-sectional view of the second seal for the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 15 is a side elevational view of the front brake disc hub of the front wheel illustrate FIG. 1;

FIG. 16 is a side elevational view of the front brake disc hub of the front wheel illustrated in FIG. 1 with certain portions broken away for purposes of illustration;

FIG. 17 is a partial cross-sectional view of the first seal for the front brake disc hub body illustrated in FIGS. 15 and 16;

FIG. 18 is a partial cross-sectional view of the second seal for the front brake disc hub body illustrated in FIGS. 15 and 16;

FIG. 19 is a perspective view of a first embodiment of a spoke opening cover for the hubs of the present invention;

FIG. 20 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIG. 19 installed thereon;

FIG. 21 is a perspective view of a second embodiment of a spoke opening cover for the hubs of the present invention;

FIG. 22 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIG. 21 installed thereon;

FIG. 23 is an inside elevational view of a third embodiment of a spoke opening cover fore hubs of the present invention;

FIG. 24 is an edge elevational view of the spoke opening cover illustrated in FIG. 23 for the hubs of the present invention;

FIG. 25 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIGS. 23 and 24 installed thereon;

FIG. 26 is a side elevational view of the rear brake disc hub in accordance with a second embodiment of the present invention with the sprockets removed;

FIG. 27 a side elevational view of the rear brake disc hub illustrated in FIG. 26 in accordance with a second embodiment of the present invention with certain portions broken away for purposes of illustration;

FIG. 28 is a side elevational view of the front brake disc hub in accordance with a second embodiment of the present invention with the sprockets removed; and

FIG. 29 a side elevational view of the front brake disc hub illustrated in FIG. 28 in accordance with a second embodiment of the present invention with certain portions broken away for purposes of illustration.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1–3, a bicycle 10 is illustrated with certain parts being modified in accordance with the present invention as discussed below. The bicycle 10 basically has a frame 12 with a front fork 13 movably coupled thereto. A rear wheel 14 is rotatably coupled to a rear portion of the frame 12, while a front wheel 16 is rotatably coupled to the front fork 13. The frame 12 also has a seat 18 adjustably coupled to frame 12, a handlebar 19 coupled to front fork 13 for turning front wheel 16 and a drive train 20 for propelling bicycle 10. The bicycle 10 is also provided with a pair of disc brake assemblies 21 having a caliper 21a and a brake lever 21b.

Since these parts of bicycle 10 are well known in the art, these parts will not be discussed or illustrated in detail herein, except as they are modified in accordance with the present invention. Moreover, various conventional bicycle parts such as brakes, derailleurs, additional sprocket, etc., which are not illustrated and/or discussed in detail herein, can be used in conjunction with the present invention.

As seen in FIG. 2, the rear wheel 14 has a rear hub 22, a plurality of spokes 24 extending outwardly from the rear hub 22, a rim 26 coupled to the outer ends of spokes 24 by spoke nipples 28, and a tire 30 located on the outer surface of rim 26. The rear hub 22 is also provided with a brake disc rotor 32 that is attached to the rear hub 22 by six blots 32a and six nuts 32b, as explained below. While the illustrated embodiment is a thirty-six spoke wheel, it will be apparent to those skilled in the art from this disclosure that other spoke arrangements are possible without departing from the present invention. For example, a thirty-two spoke wheel or a forty spoke wheel can be constructed in accordance with the present invention without departing from the present invention. Basically, the number of spoke openings depends upon the rim to be used with the hub of the present invention.

Preferably, the spokes 24, the rim 26 and spoke nipples 28 are all conventional parts that are used with the rear hub 22 of the present invention as seen in FIG. 3. In other words, the unique design of the rear hub 22 allows it to be used with conventional parts, e.g., tangential spokes 24 and a conventional rim 26. Accordingly, when the rear wheel 14 is assembled, the spokes 24 extend tangentially from an imaginary circle centered on the center axis of rotation of rear hub 22. In the illustrated embodiment of FIGS. 2–5, the rear hub 22 and the rim 26 has thirty-six of the spokes 24 coupled therebetween.

The term “tangential spokes” are spokes that have a straight section 24a and a bent end 24b with an enlarged head 24c such that straight section 24a extends at an angle of about 95° relative to the bent end 24b. Such spokes are well known in the bicycle art. As seen in FIG. 3, the spokes 24 of the illustrated embodiment each have an outer threaded end 24d that is located at the opposite end of the center straight section 24a from the bent end 24b (inner end portion) with the enlarged head 24c. The bent end 24b has a center axis that forms an angle of about 95° with the center axis of the straight section 24a. The bent ends 24b of the spokes 24 are designed to be received within the first and second spoke openings. In particular, the enlarged heads 24c of the spokes 24 engage an interior surface of the hub body 38 with the straight sections 24a extending substantially tangentially to an imaginary circle with a center on the center axis of rotation of the rear hub 22.

The rim 26 can be any conventional rim that has a plurality of spoke holes 34 for receiving the spoke nipples 28



for attaching the outer threaded ends **24d** of the spokes **24** thereto. In the illustrated embodiment, the rim **26** is a conventional steel or alloy rim having a U-shaped cross section with thirty-six spoke holes **34**. The spoke holes **34** are equally spaced apart in a circumferential direction. The spoke holes **34** are preferably lie in a single plane P that divides the cross section in half as seen in FIG. 3. Of course, rims with fewer or more spoke holes **34** can be used with a hub of the present invention, if needed and/or desired. For example, the rim **26** can have thirty-two spoke holes instead of thirty-six spoke holes, if the rear hub **22** is modified to have fewer holes as explained below.

#### REAR HUB 22

As best seen in FIG. 5, the rear hub **22** basically includes a hub axle **36**, a hub body or shell **38**, a first bearing assembly **40a**, a second bearing assembly **40b**, a first spoke seal **42a**, a second spoke seal **42b**, a freewheel **44** and a quick release mechanism **46**. Of the parts of rear hub **22**, only the hub body **38** and the first and second spoke seals **42a** and **42b** are non-conventional parts. The remaining parts of rear hub **22** are relatively conventional, and thus, the remaining parts of rear hub **22** will not be discussed or illustrated in detail herein.

The hub axle **36** has a center axis A extending between a first end **36a** and a second end **36b**. The quick release mechanism **46** extends through a center bore **36c** of the hub axle **36** such that the quick release mechanism **46** is coupled to the hub axle **36** in a conventional manner. The first and second ends **36a** and **36b** of the hub axle **36** are threaded for receiving a pair of nuts **50a** and **50b** that applies an axial force on the hub body **38**, the bearing assemblies **40a** and **40b**, the spoke seals **42a** and **42b**, and the freewheel **44**. First and second bearing assemblies **40a** and **40b** rotatably mount the hub body **38** with the freewheel **44** on the hub axle **36**. The freewheel **44** allows the hub axle **36** to rotate freely relative to the hub body **38** in one direction, but fixedly couples the hub axle **36** relative to the hub body **38** in the opposite rotational direction.

The hub body **38** is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body **38** is a hollow member that defines an interior passageway **52** with the hub axle **36** being rotatably supported therein by the first and second bearing assemblies **40a** and **40b**. Thus, the hub body **38** is a substantially tubular member. Specifically, the hub body **38** has a center tubular portion **38c** with first and second end sections **38a** and **38b** being integral formed with the center tubular portion **38c** as a one-piece, unitary member. The first end section **38a** has an integrally mounted brake rotor attachment portion **38d**, while a second end section **38b** has the freewheel **44** fixedly coupled thereto.

A set of first spoke openings **60a** are provided at the first end section **38a** of the hub body **38** for receiving the bent ends **24b** of the spokes **24**. Similarly, the second end section **38b** of the hub body **38** is provided with a second set of spoke openings **60b** for receiving the bent ends **24b** of the spokes **24**. In the illustrated embodiment, the first end section **38a** is provided with nine of the first spoke openings **60a** and the second end section **38b** is provided with nine of the second spoke openings **60b**. The spoke openings **60a** and **60b** are equally spaced apart about the circumference of the hub body **38**. Each of the spoke openings **60a** and **60b** are also designed to receive two spokes **24** as explained below. Accordingly, the rear hub **22** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **60a** and **60b** are identical. The first and second spoke openings

**60a** and **60b** are designed to be used with conventional tangential spokes **24**. Of course, it is possible that the first and second sets of spoke openings **60a** and **60b** can be different such that tangential spokes **24** are used in one end of the hub body **38** and a different types of spokes are used in the other end of the hub body **38**. The first spoke openings **60a** are circumferentially arranged around the hub body **38** adjacent to the brake rotor attachment portion **38d**. Preferably, the first spoke openings **60a** are spaced axially inward of the brake rotor attachment portion **38d** so that brake disc rotor **32** can be easily attached with the bolts **32a** and nuts **32b**.

In this embodiment, the first and second spoke openings **60a** and **60b** are elongated slots that are each provided with an insertion portion **61** and a pair of retaining portions **62**. Accordingly, each of the spoke openings **60a** and **60b** is designed to have a pair of spokes **24** retained therein with the spokes **24** extending in opposite directions.

The insertion portion **61** of each spoke opening is located between the pair of retaining portions **62** of each spoke opening. Each insertion portion **61** is formed by a pair of opposed curved surfaces **64** that are spaced apart so as to be equal to or slightly larger than the widths or diameters of the enlarged heads **24c** of the spokes **24**. Thus, the inner ends (bent ends **24b** with enlarged heads **24c**) of the spokes **24** can be easily inserted into the spoke openings **60a** and **60b** through the insertion portions **61**.

The retaining portions **62** have smaller widths or diameters than the insertion portions **61**. More specifically, the diameters or widths of the retaining portions **62** are smaller than the diameters or widths of the enlarged heads **24c** of the spokes **24** so as to retain the spokes **24** within the spoke openings **60a** and **60b**. The retaining portions **62** are each preferably defined by a partial cylindrical surface **66** that is connected to the curved surfaces **64** of the associated insertion portion **61** by a pair of straight surfaces **68**.

The spoke openings **60a** and **60b** are formed as elongated slots that are angled relative to the axis A. Accordingly, the insertion portions **61** are arranged in a circumferential pattern with one set of the retaining portions **62** being located axially outward from the insertion portions **61** and the other set of retaining portions **62** being spaced axially inward from the insertion portions **61**. In other words, a first set of retaining portions **62** form an outer circumferential row of the retaining portions **62**, and a second set of the retaining portions **62** form an inner circumferential row of retaining portions **62** with the insertion portions **61** being located between the rows of retaining portions **62**.

Preferably, the insertion portion **61** and the retaining portions **62** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **62** of the spoke openings **60a** and **60b** are tapered to avoid sharp edges engaging the spokes **24**.

Each of the insertion portions **61** has a center longitudinal axis  $C_1$  that passes through the center axis A of the hub axle **36**. The retaining portions **62**, on the other hand, have center longitudinal axes  $C_2$  that are parallel to the center longitudinal axis  $C_1$  of the insertion portion **61** for each of the spoke openings **60a** and **60b**. Thus, the center longitudinal axes  $C_2$  of the retaining portions **62** do not pass through the center axis of the hub axle **36**. Rather, the center longitudinal axes  $C_2$  of the retaining portions **62** are angled with respect to center axis A. Preferably, the center longitudinal axis  $C_2$  of each retaining portion **62** is angled between about  $5^\circ$  and about  $20^\circ$  from a radial orientation in the hub body **38**. In the illustrated embodiment, the retaining portions **62** are angled about  $10^\circ$  with respect to center axis A for a twenty-six inch



rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **62** are preferably angled about  $11^\circ$  with respect to center axis A. This angled configuration of the retaining portions **62** results in the straight sections **24a** of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **38**. Moreover, this angled configuration of the retaining portions **62** allows the straight sections **24a** of the spokes **24** to be easily aligned with the spoke holes **34** of the rim **26** without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees. Of course, the less bending of the spokes **24**, the better.

If the retaining portions **62** were formed with their center axis passing through the center axis A of the hub axle **36**, then the conventional spokes **24** would be placed under excessive bending forces, which could result in the spokes **24** breaking during use of the wheel. In particular, if the retaining portions **62** have their center axes passing through the center of the hub axle **36**, then the center straight section **24a** would have to be bent from  $95^\circ$  to  $108^\circ$  for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. In contrast, with the retaining portions **62** of the spokes **24** being angled, the amount of bending of the spokes **24** can be reduced and/or eliminated.

The brake rotor attachment portion **38d** is integrally formed with the center tubular portion **38c** of the hub body **38** as a one-piece, unitary member. In the illustrated embodiment, the brake rotor attachment portion **38d** is formed with six attachment members or points with through bores **70**. While six individual attachment points are illustrated, it will be apparent to those skilled in the art from this disclosure that fewer or more attachment points can be utilized. Moreover, it will be apparent to those skilled in the art from this disclosure that the attachment portions could be a continuous flange, if needed and/or desired. The through bore **70** can be threaded (FIG. 7) or unthreaded (bores **70'** of FIG. 8). By using through bores **70** instead of blind bores, the rear hub **22** can be easily manufactured at a relatively lower cost.

As seen in FIG. 8, the through bores **70''** can be unthreaded bores. In the case of unthreaded through bores **70''**, the bolts **32a** extend into openings in the brake disc rotor **32** and then through the through bores **70''**. The free ends of the bolts **32a** have nuts **32b** threaded thereon for attaching the brake disc rotor **32** to the hub body **38**. This arrangement allows the hub body **38** and the brake rotor attachment portion **38d** to be formed out of the same a lightweight material, such as aluminum. In this arrangement, the hub body **38** does not need to be replaced if the through bores **70''** become damaged.

As seen in FIG. 7, the through bores **70** are threaded. In the case of threaded through bores **70**, the bolts **32a** extend into openings in the brake disc rotor **32** and then threaded into the through bores **70**. Optionally, the free ends of the bolts **32a** can have the nuts **32b** threaded thereon for more securely attaching the brake disc rotor **32** to the hub body **38**. In this arrangement, if the threads of through bores **70** become damaged, the hub body **38** does not need to be replaced. Rather, the bolts **32a** and the nuts **32b** securely attach the brake disc rotor **32** to the hub body **38**.

Bearing assemblies **40a** and **40b** rotatably supports hub body **38** on hub axle **36**. The bearing assembly **40a** basically includes a plurality of balls **74a** located between an inner

race member **76a** and an outer race member **78a**. Similarly, the bearing assembly **40b** basically includes a plurality of balls **74b** located between an inner race member **76b** and an outer race member **78b**. Since bearing assemblies **40a** and **40b** are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

Turning now to FIGS. 13 and 14, the spoke seals **42a** and **42b** form a seal structure that is arranged in the interior passageway **52** of the hub body **38** so as to be adjacent the spoke openings **60a** and **60b** to isolate the spoke openings **60a** and **60b** from the hub axle **36**. In other words, the spoke seals **42a** and **42b** prevent contaminants from entering the rear hub **22** through the spoke openings **60a** and **60b**. The spoke seals **42a** and **42b** are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement.

In the preferred embodiment, the spoke seals **42a** and **42b** also aid in the assembly of the spokes **24** with the hub body **38** and the rim **26**. Specifically, in the preferred embodiments, the seals **42a** and **42b** are arranged so that they restrain movement of the spokes **24** within the spoke openings **60a** and **60b** so that the bent ends **24b** of the spokes **24** stays in the retaining portions **62** of the spoke openings **60a** and **60b**.

In the illustrated embodiment, the spoke seal **42a** has a tubular section **80a** and a center annular flange **82a**. The center annular flange **82a** extends in a circumferential direction about the tubular section **80a**. The center annular flange **82a** can either contact the interior surface of the tubular section **80a** or be spaced from the tubular section **80a**. The ends **84a** and **86a** of the tubular section **80a** are configured to engage a ring member **88a** and an abutment **90a** of the inner surface of the hub body **38**. Of course, the particular shape of the ends **84a** and **86a** will vary depending on the shape of the hub body **38** and its internal components. Preferably, ends **84a** and **86a** of the tubular section **80a** are annular flanges that contact the interior surface of the tubular section **80a** to form an isolated area beneath the spoke openings **60a**. This isolated area beneath the spoke openings **60a** is a continuous annular space.

When the rear hub **22** is assembled, an axial force is applied to the ends **84a** and **86a** of the tubular section **80a** to form annular seals therebetween. Thus, the ends **84a** and **86a** together with the tubular section **80a** form a first sealing portion of the seal **42a**. At least portion of the center flange **82a** with the groove **92a** extending from the tubular section **80a** forms a first maintaining portion of the seal **42a**. Accordingly, the spoke seal **42a** isolates a first interior section of the interior passageway **52** from the remainder of the interior passageway **52**. This interior section formed by the spoke seal **42a** is continuous annular first space located beneath the spoke openings **60a**.

When the rear hub **22** is assembled, an axial force is applied to the ends **84b** and **86b** of the tubular section **80b** to form annular seals therebetween. Thus, the ends **84b** and **86b** together with the tubular section **80b** form a second sealing portion of the seal **42b**. At least portion of the center flange **82b** with the groove **92b** extending from the tubular section **80b** forms a second maintaining portion of the seal **42b**. Accordingly, the spoke seal **42b** isolates a second interior section of the interior passageway **52** from the remainder of the interior passageway **52**. This interior section formed by the spoke seal **42b** is continuous annular second space located beneath the spoke openings **60b**.

The center annular flange **82a** is preferably aligned with a circumferentially passing through the center axes  $C_1$  of the



insertion portion **61** of the first spoke openings **60a**. Thus, the center annular flange **82a** is positioned to axially separate the two retaining portions **62** of each of the first spoke openings **60a** from each other. The center annular flange **82a** is also positioned to keep spokes **24** in the retaining portions **62** of the first spoke openings **60a**. Accordingly, when the enlarged heads **24c** of the spokes **24** are inserted into the insertion portions **61** of the spoke openings **60a**, the enlarged heads **24c** of the spokes **24** contact the center annular flange **82a**. The enlarged heads **24c** then pushes or deforms the center annular flange **82a** one way or the other so that the enlarged heads **24c** extends into the insertion portions **61** of the spoke openings **60a**. The spokes **24** are then moved or slid into one of the two retaining portions **62** of each of the spoke openings **60a**. The center annular flange **82a** will prevent the spokes **24** from accidentally falling out of the insertion portions **61** of the spoke openings **60a**. Thus, the center annular flange **82a** aids in the assembly of the rear wheel **14**. In other words, the center annular flange **82a** must be moved or deformed again before the spokes **24** can be removed from the spoke openings **60a**. For added resiliency, an annular groove **92a** can be formed in the outer peripheral surface of the center flange **82a**.

Similar to the spoke seal **42a**, the spoke seal **42b** has a tubular section **80b** and a center annular flange **82b**. The center annular flange **82a** extends in a circumferential direction about the tubular section **80a**. Alternatively, the center annular flanges **82a** and **82b** of the spoke seals **42a** and **42b** can each have a pair of center annular flanges. The ends **84b** and **86b** of the tubular section **80b** are configured to engage a ring member **88b** and an abutment **90b** of the inner surface of the hub body **38**. Of course, the particular shape of the ends **84b** and **86b** will vary depending on the shape of the hub body **38** and its internal components. Preferably, ends **84b** and **86b** of the tubular section **80b** are annular flanges that contact the interior surface of the tubular section **80b** to form an isolated area beneath the spoke openings **60b**. This isolated area beneath the spoke openings **60b** is a continuous annular space.

When the rear hub **22** is assembled, an axial force is applied to the ends **84b** and **86b** of the tubular section **80b** to form annular seals therebetween. Accordingly, the spoke seal **42b** isolates a second interior section of the interior passageway **52** from the remainder of the interior passageway **52**. This interior section formed by the spoke seal **42b** is continuous annular second space located beneath the spoke openings **60b**.

Similar to the center annular flange **82a**, the center annular flange **82b** is preferably aligned with a circumferentially passing through the centers axes  $C_1$  of the insertion portions **61** of the second spoke openings **60b**. Thus, the center annular flange **82b** is positioned to axially separate the two retaining portions **62** of each of the second spoke openings **60b** from each other. The center annular flange **82b** is also positioned to keep spokes **24** in the retaining portions **62** of the second spoke openings **60b**. Accordingly, when the enlarged heads **24c** of the spokes **24** are inserted into the insertion portions **61** of the spoke openings **60b**, the enlarged heads **24c** of the spokes **24** contact the center annular flange **82b**. The enlarged heads **24c** then pushes or deforms the center annular flange **82b** one way or the other so that the enlarged heads **24c** extends into the insertion portions **61** of the spoke openings **60b**. The spokes **24** are then moved or slid into one of the two retaining portions **62** of each of the spoke openings **60b**. The center annular flange **82b** will prevent the spokes **24** from accidentally falling out of the insertion portions **61** of the spoke openings **60b**. Thus, the

center annular flange **82b** aids in the assembly of the rear wheel **14**. In other words, the center annular flange **82b** must be moved or deformed again before the spokes **24** can be removed from the spoke openings **60b**. For added resiliency, an annular groove **92b** can be formed in the outer peripheral surface of the center flange **82b**.

The freewheels, such as the freewheel **44**, are well known in the bicycle art, and thus, the freewheel **44** will not be illustrated or discussed in detail herein. The freewheel **44** is used to transmit a driving force from the chain to the rear bicycle wheel in one rotation direction only. The freewheel **44** allows the bicycle **10** to advance freely without any rotation of the pedals. The freewheel **44** is fastened to the rear hub **22** as integral part of the rear hub **22** in a conventional manner. The freewheel **44** has an outer tubular part **94**, an inner tubular part **96** and a one-way clutch **98**. The inner tubular part **96** is installed radially inwardly of the outer tubular part **94** so that the inner tubular part **96** is free to rotate relative to the outer tubular part **94**. The one-way clutch **98** is installed between the outer tubular part **94** and inner tubular part **96** for transmitting the driving force from the outer tubular part **94** to the inner tubular part **96** in one rotational direction only. The outer tubular part **94** has a plurality of gears or sprockets (not shown) mounted thereon, while the inner tubular part **96** is usually mounted on the hub axle **36**.

#### FRONT HUB 22'

Turning now to FIGS. **15** and **16**, the front hub **22'** is illustrated in accordance with the present invention. The front hub **22'** is substantially the same as the rear hub **22**, except that the front hub **22'** does not have a freewheel and the spoke openings **60a'** and **60b'** are angled in the opposite direction from spoke openings **60a** and **60b** of the rear hub **22**. Moreover, the front hub **22'** is used with spokes **24** and rim **26** discussed above. Since the front hub **22'** is substantially the same as the rear hub **22**, the front hub **22'** will not be discussed or illustrated in detail herein.

The front hub **22'** basically includes a hub axle **36'**, a hub body or shell **38'**, a first bearing assembly **40a'**, a second bearing assembly **40b'**, a first spoke seal **42a'**, a second spoke seal **42b'** and a quick release mechanism **46'**. Of the parts of front hub **22'**, only the hub body **38'** and the first and second spoke seals **42a'** and **42b'** are non-conventional parts. The remaining parts of front hub **22'** are relatively conventional, and thus, the remaining parts of front hub **22'** will not be discussed or illustrated in detail herein.

The hub axle **36'** has a center axis **A** extending between a first end **36a'** and a second end **36b'**. The quick release mechanism **46'** extends through a center bore **36c'** of the hub axle **36'** such that the quick release mechanism **46'** is coupled to the hub axle **36'** in a conventional manner. The first and second ends **36a'** and **36b'** of the hub axle **36'** are threaded for receiving a pair of nuts **50a'** and **50b'** that applies an axial force on the hub body **38'**, the bearing assemblies **40a'** and **40b'** and the spoke seals **42a'** and **42b'**. First and second bearing assemblies **40a'** and **40b'** rotatably mount the hub body **38'** on the hub axle **36'**.

The hub body **38'** is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body **38'** is a hollow member that defines an interior passageway **52'** with the hub axle **36'** being rotatably supported therein by the first and second bearing assemblies **40a'** and **40b'**. Thus, the hub body **38'** is a substantially tubular member. Specifically, the hub body **38'** has a center tubular portion **38c'** with first and second end sections **38a'** and **38b'** being integral formed with the center tubular portion **38c'** as a one-piece, unitary member. The first end



section **38a'** has an integrally mounted brake rotor attachment portion **38d'**.

A set of first spoke openings **60a'** are provided at the first end section **38a'** of the hub body **38'** for receiving the bent ends **24b** of the spokes **24**. Similarly, the second end section **38b'** of the hub body **38'** is provided with a second set of spoke openings **60b'** for receiving the bent ends **24b** of the spokes **24**. In the illustrated embodiment, the first end section **38a'** is provided with nine of the first spoke openings **60a'** and the second end section **38b'** is provided with nine of the second spoke openings **60b'**. The spoke openings **60a'** and **60b'** are equally spaced apart about the circumference of the hub body **38'**. Each of the spoke openings **60a'** and **60b'** are also designed to receive two spokes **24** as explained below. Accordingly, the front hub **22'** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **60a'** and **60b'** are identical. The first and second spoke openings **60a'** and **60b'** are designed to be used with conventional tangential spokes **24**. Of course, it is possible that the first and second sets of spoke openings **60a'** and **60b'** can be different such that tangential spokes **24** are used in one end of the hub body **38'** and a different types of spokes are used in the other end of the hub body **38'**. The first spoke openings **60a'** are circumferentially arranged around the hub body **38'** adjacent to the brake rotor attachment portion **38d'**. Preferably, the first spoke openings **60a'** are spaced axially inward of the brake rotor attachment portion **38d'** so that brake disc rotor **32'** can be easily attached with the bolts **32a'** and nuts **32b'**.

In this embodiment, the first and second spoke openings **60a'** and **60b'** are elongated slots that are each provided with an insertion portion **61'** and a pair of retaining portions **62'**. Accordingly, each of the spoke openings **60a'** and **60b'** is designed to have a pair of spokes **24** retained therein with the spokes **24** extending in opposite directions.

The insertion portion **61'** of each spoke opening is located between the pair of retaining portions **62'** of each spoke opening. Each insertion portion **61'** is formed by a pair of opposed curved surfaces **64'** that are spaced apart so as to be equal to or slightly larger than the widths or diameters of the enlarged heads **24c** of the spokes **24**. Thus, the inner ends (bent ends **24b** with enlarged heads **24c**) of the spokes **24** can be easily inserted into the spoke openings **60a'** and **60b'** through the insertion portions **61'**.

The retaining portions **62'** have smaller widths or diameters than the insertion portions **61'**. More specifically, the diameters or widths of the retaining portions **62'** are smaller than the diameters or widths of the enlarged heads **24c** of the spokes **24** so as to retain the spokes **24** within the spoke openings **60a'** and **60b'**. The retaining portions **62'** are each preferably defined by a partial cylindrical surface **66'** that is connected to the curved surfaces **64'** of the associated insertion portion **61'** by a pair of straight surfaces **68'**.

The spoke openings **60a'** and **60b'** are formed elongated slots that are angled relative to the axis **A'**. Accordingly, the insertion portions **61'** are arranged in a circumferential pattern with one set of the retaining portions **62'** being located axially outward from the insertion portions **61'** and the other set of retaining portions **62'** being spaced axially inward from the insertion portions **61'**. In other words, a first set of retaining portions **62'** form an outer circumferential row of the retaining portions **62'**, and a second set of the retaining portions **62'** form an inner circumferential row of retaining portions **62'** with the insertion portions **61'** being located between the rows of retaining portions **62'**.

Preferably, the insertion portion **61'** and the retaining portions **62'** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **62'** of the spoke openings **60a'** and **60b'** are tapered to avoid sharp edges engaging the spokes **24**.

Each of the insertion portions **61'** has a center longitudinal axis  $C_1'$  that passes through the center axis **A'** of the hub axle **36'**. The retaining portions **62'**, on the other hand, have center longitudinal axes  $C_2'$  that are parallel to the center longitudinal axis  $C_1'$  of the insertion portion **61'** for each of the spoke openings **60a'** and **60b'**. Thus, the center longitudinal axes  $C_2'$  of the retaining portions **62'** do not pass through the center axis of the hub axle **36'**. Rather, the center longitudinal axes  $C_2'$  of the retaining portions **62'** are angled with respect to center axis **A'**. Preferably, the center longitudinal axis  $C_2'$  of each retaining portion **62'** is angled between about  $5^\circ$  and about  $20^\circ$  from a radial orientation in the hub body **38'**. In the illustrated embodiment, the retaining portions **62'** are angled about  $10^\circ$  with respect to center axis **A** for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **62'** are preferably angled about  $11^\circ$  with respect to center axis **A'**. This angled configuration of the retaining portions **62'** results in the straight sections **24a** of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **38'**. Moreover, this angled configuration of the retaining portions **62'** allows the straight sections **24a** of the spokes **24** to be easily aligned with the spoke holes **34** of the rim **26** without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees.

If the retaining portions **62'** were formed with their center axis passing through the center axis **A** of the hub axle **36'**, then the conventional spokes **24** would be placed under excessive bending forces, which could result in the spokes **24** breaking during use of the wheel. In particular, if the retaining portions **62'** have their center axes passing through the center of the hub axle **36'**, then the center straight section **24a** would have to be bent from  $95^\circ$  to  $108^\circ$  for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. In contrast, with the retaining portions **62'** of the spokes **24** being angled, the amount of bending of the spokes **24** can be reduced and/or eliminated.

The brake rotor attachment portion **38d'** is integrally formed with the center tubular portion **38c'** of the hub body **38'** as a one-piece, unitary member. In the illustrated embodiment, the brake rotor attachment portion **38d'** is formed with six attachment members or points with through bores **70'**. While six individual attachment points are illustrated, it will be apparent to those skilled in the art from this disclosure that fewer or more attachment points can be utilized. Moreover, it will be apparent to those skilled in the art from this disclosure that the attachment portions could be a continuous flange, if needed and/or desired. The through bore **70'** can be threaded or unthreaded. By using through bores **70'** instead of blind bores, the front hub **22'** can be easily manufactured at a relatively lower cost.

In the case of unthreaded through bores **70'**, the bolts **32a'** extend into openings in the brake disc rotor **32'** and then through the through bores **70'**. The free ends of the bolts **32a'** have nuts **32b'** threaded thereon for attaching the brake disc rotor **32'** to the hub body **38'**. This arrangement allows the hub body **38'** and the brake rotor attachment portion **38d'** to



be formed out of the same a lightweight material, such as aluminum. Moreover, the hub body 38' does not need to be replaced if the through bores 70' become damaged.

In the case of threaded through bores 70', the bolts 32a' extend into openings in the brake disc rotor 32' and then threaded into the through bores 70'. Optionally, the free ends of the bolts 32a' can have the nuts 32b' threaded thereon for more securely attaching the brake disc rotor 32' to the hub body 38'. In this arrangement, if the threads of through bores 70' become damaged, the hub body 38' does not need to be replaced. Rather, the bolts 32a' and the nuts 32b' securely attach the brake disc rotor 32' to the hub body 38'.

Bearing assemblies 40a' and 40b' rotatably supports hub body 38' on hub axle 36'. The bearing assembly 40a' basically includes a plurality of balls 74a' located between an inner race member 76a' and an outer race member 78a'. Similarly, the bearing assembly 40b' basically includes a plurality of balls 74b' located between an inner race member 76b' and an outer race member 78b'. Since bearing assemblies 40a' and 40b' are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

Turning now to FIGS. 17 and 18, the spoke seals 42a' and 42b' are arranged in the interior passageway 52' of the hub body 38' so as to be adjacent the spoke openings 60a' and 60b' to isolate the spoke openings 60a' and 60b' from the hub axle 36. In other words, the spoke seals 42a' and 42b' prevent contaminants from entering the front hub 22' through the spoke openings 60a' and 60b'. The spoke seals 42a' and 42b' are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement. Moreover, it will be apparent to those skilled in the art from this disclosure that while the spoke seals 42a' and 42b' are illustrated as a pair of separate sealing members, the spoke seals 42a' and 42b' can be formed as a one-piece, unitary member.

In the preferred embodiment, the spoke seals 42a' and 42b' also aid in the assembly of the spokes 24 with the hub body 38' and the rim 26. Specifically, in the preferred embodiments, the seals 42a' and 42b' are arranged so that they restrain movement of the spokes 24 within the spoke openings 60a' and 60b' so that the bent ends 24b of the spokes 24 stays in the retaining portions 62' of the spoke openings 60a' and 60b'.

In the illustrated embodiment, the spoke seal 42a' has a tubular section 80a' and a center annular flange 82a'. The center annular flange 82a' extends in a circumferential direction about the tubular section 80a'. The ends 84a' and 86a' of the tubular section 80a' are configured to engage a ring member 88a' and an abutment 90a' of the inner surface of the hub body 38'. Of course, the particular shape of the ends 84a' and 86a' will vary depending on the shape of the hub body 38' and its internal components. In other words, the spoke seal 42a' functions the same way as the spoke seal 42a of the rear hub 22, but has a slightly modified ends 84a' and 86a' to accommodate front hub 22'.

When the front hub 22' is assembled, an axial force is applied to the ends 84a' and 86a' of the tubular section 80a' to form annular seals therebetween. Accordingly, the spoke seal 42a' isolates a first interior section of the interior passageway 52' from the remainder of the interior passageway 52'. This interior section formed by the spoke seal 42a' is continuous annular first space located beneath the spoke openings 60a'.

The center annular flange 82a' is preferably aligned with a circumferentially passing through the centers axes C<sub>1</sub>' of

the insertion portions 61' of the first spoke openings 60a'. Thus, the center annular flange 82a' is positioned to axially separate the two retaining portions 62' of each of the first spoke openings 60a' from each other. The center annular flange 82a' is also positioned to keep spokes 24 in the retaining portions 62' of the first spoke openings 60a'. Accordingly, when the enlarged heads 24c of the spokes 24 are inserted into the insertion portions 61 of the spoke openings 60a', the enlarged heads 24c of the spokes 24 contact the center annular flange 82a'. The enlarged heads 24c then pushes or deforms the center annular flange 82a' one way or the other so that the enlarged heads 24c extends into the insertion portions 61' of the spoke openings 60a'. The spokes 24 are then moved or slid into one of the two retaining portions 62' of each of the spoke openings 60a. The center annular flange 82a' will prevent the spokes 24 from accidentally falling out of the insertion portions 61' of the spoke openings 60a'. Thus, the center annular flange 82a' aids in the assembly of the front wheel 16. In other words, the center annular flange 82a' must be moved or deformed again before the spokes 24 can be removed from the spoke openings 60a'. For added resiliency, an annular groove 92a' can be formed in the outer peripheral surface of the center flange 82a'.

Similar to the spoke seal 42a', the spoke seal 42b' has a tubular section 80b' and a center annular flange 82b'. The center annular flange 82a' extends in a circumferential direction about the tubular section 80a'. Alternatively, the center annular flanges 82a' and 82b' of the spoke seals 42a' and 42b' can each have a pair of center annular flanges. The ends 84b' and 86b' of the tubular section 80b' are configured to engage a ring member 88b' and an abutment 90b' of the inner surface of the hub body 38'. Of course, the particular shape of the ends 84b' and 86b' will vary depending on the shape of the hub body 38' and its internal components. When the front hub 22' is assembled, an axial force is applied to the ends 84b' and 86b' of the tubular section 80b' to form annular seals therebetween. Accordingly, the spoke seal 42b' isolates a second interior section of the interior passageway 52' from the remainder of the interior passageway 52'. This interior section formed by the spoke seal 42b' is continuous annular second space located beneath the spoke openings 60b'.

Similar to the center annular flange 82a', the center annular flange 82b' is preferably aligned with a circumferentially passing through the centers axes C<sub>1</sub> of the insertion portions 61' of the second spoke openings 60b'. Thus, the center annular flange 82b' is positioned to axially separate the two retaining portions 62' of each of the second spoke openings 60b' from each other. The center annular flange 82b' is also positioned to keep spokes 24 in the retaining portions 62' of the second spoke openings 60b'. Accordingly, when the enlarged heads 24c of the spokes 24 are inserted into the insertion portions 61' of the spoke openings 60b', the enlarged heads 24c of the spokes 24 contact the center annular flange 82b'. The enlarged heads 24c then pushes or deforms the center annular flange 82b' one way or the other so that the enlarged heads 24c extends into the insertion portions 61' of the spoke openings 60b'. The spokes 24 are then moved or slid into one of the two retaining portions 62 of each of the spoke openings 60b'. The center annular flange 82b' will prevent the spokes 24 from accidentally falling out of the insertion portions 61' of the spoke openings 60b'. Thus, the center annular flange 82b' aids in the assembly of the front wheel 16. In other words, the center annular flange 82b' must be moved or deformed again before the spokes 24 can be removed from the spoke openings 60b'. For added resiliency, an annular groove 92b' can be formed in the outer peripheral surface of the center flange 82b'.



## SPOKE OPENING COVERS

As seen in FIGS. 19 and 20, a spoke opening cover 100 in accordance with one embodiment of the present invention is illustrated for use with the front hub 22' of FIGS. 15 and 16. Of course, the spoke opening cover 100 can be used with the rear hub 22 of FIGS. 4 and 5 by turning the spoke opening cover 100 inside out to reverse the direction of the slits 102. Although for purposes of brevity, the spoke opening cover 100 will only be illustrated with the front hub 22'.

The spoke opening cover 100 is used to limit or prevent contaminants from entering the hub body 38 or 38' via the spoke openings 60a, 60a' or 60b, 60b', respectively. The spoke opening cover 100 can be used instead of the spoke seals 42a, 42a' and 42b, 42b', or in conjunction with the spoke seals 42a, 42a' and 42b, 42b'. The spoke opening cover 100 basically has a resilient tubular body 101 constructed from a flexible material such as rubber. The spoke opening cover 100 has a plurality of slits 102 spaced circumferential around the tubular body 101. The tubular body 101 of the spoke opening cover 100 is configured and dimensioned to snugly fit around the bicycle hub 22' so that the spoke openings are aligned with the slits. The spoke opening cover 100 is installed on each end of the hub body 38' prior to installation of spokes 24. Since this embodiment is used with the bicycle hubs 22 and 22', the slits 102 extend diagonally relative a center axis of the tubular body. The slits 102 have enlarged openings 104 at each end. The enlarged openings 104 align with the retaining portions 62' of the spoke openings 60a' or 60b', while the center sections of the slits 102 overlie the insertion portions 61' of the spoke openings 60a' or 60b'. Also, the center sections of the slits 102 hold the spokes 24 in the retaining portions 62' to aid in the assembly of the wheel.

As seen in FIGS. 21 and 22, a spoke opening cover 100' in accordance with an alternate embodiment of the present invention is illustrated for use with the bicycle either the rear hub 22 of FIGS. 4 and 5 or the front hub 22' of FIGS. 15 and 16. Although for purposes of brevity, the spoke opening cover 100' will only be illustrated with the front hub 22'.

The spoke opening cover 100' is used to limit or prevent contaminants from entering the hub body 38 or 38' via the spoke openings 60a, 60a' or 60b, 60b', respectively. The spoke opening cover 100' can be used instead of the spoke seals 42a, 42a' and 42b, 42b', or in conjunction with the spoke seals 42a, 42a' and 42b, 42b'. In this embodiment, the spoke opening cover 100' is a thin flexible strip or body portion 101' having a first end 102' and a second end 104' with a predetermined length therebetween. The first end 102' is provided with a first protrusion 106', while the second end 104' is provided with a second protrusion 108'. The first and second protrusions 106' and 108' are configured and dimensioned to be frictionally retained with the insertion portions 61' of the spoke openings 60a' or 60b'. Accordingly, the first and second protrusions 106' and 108' have predetermined widths or diameters that are larger than a width of an enlarged head 24c of a spoke 24. Preferably, the body portion 101' has a predetermined width that is larger than the widths or diameters of the enlarged heads 24c of the spokes 24. In other words, the body portion 101' of the spoke opening cover 100' has a predetermined width that is larger than a width of insertion portions 61' of the spoke openings 60a' or 60b'. The spoke opening cover 100' is designed to be installed on each end of the hub body 38' after the spokes 24 have been installed into the spoke openings 60a' and 60b'.

As seen in FIGS. 23-25, a spoke opening cover 100'' in accordance with another alternate embodiment of the present invention is illustrated for use with the bicycle either

the rear hub 22 of FIGS. 4 and 5 or the front hub 22' of FIGS. 15 and 16. Although for purposes of brevity, the spoke opening cover 100'' will only be illustrated with the front hub 22'.

The spoke opening cover 100'' is used to limit or prevent contaminants from entering the hub body 38 or 38' via the spoke openings 60a, 60a' or 60b, 60b', respectively. The spoke opening cover 100'' can be used instead of the spoke seals 42a, 42a' and 42b, 42b', or in conjunction with the spoke seals 42a, 42a' and 42b, 42b'. In this embodiment, the spoke opening cover 100'' is a thin flexible strip or body portion 101'' having a first end 102'' and a second end 104'' with a predetermined length therebetween.

The first end 102'' is provided with a tubular connector 106'', while the second end 104'' is provided with a mating connector 108''. The tubular connector 106'' is a protrusion that is configured and dimensioned to be received in one of the insertion portions 61' of the spoke openings 60a' or 60b'. The mating connector 108'' is a split protrusion in the form of a resilient detent. The second end 104'' is configured and dimensioned to overlap the first end 102'' with mating connector 108'' being retained in the bore of tubular protrusion 106'' via a snap-fit. The length of body portion 101'' should be such that spoke opening cover 100'' snugly fits around the hub body 38' when the detent 108'' is snap-fitted into the tubular protrusion 106''.

Preferably, the body portion 101'' has a predetermined width that is larger than the widths or diameters of the enlarged heads 24c of the spokes 24. In other words, the body portion 101'' of the spoke opening cover 100'' has a predetermined width that is larger than a width of insertion portions 61' of the spoke openings 60a' or 60b'. The spoke opening cover 100'' is designed to be installed on each end of the hub body 38' after the spokes 24 have been installed into the spoke openings 60a' and 60b'.

## Second Embodiment

Referring now to FIGS. 26-29, bicycle rear and front hubs 122 and 122' are illustrated in accordance with a second embodiment of the present invention. The rear and front hubs 122 and 122' of this second embodiment are substantially the same as the first embodiment, except that the spoke hole openings 60a, 60a' and 60b, 60b' of the first embodiment have been replaced with modified spoke openings 160a, 160a' and 160b, 160b' that each receive a single spoke as explained below. Since the rear and front hubs 122 and 122' are substantially the same as the rear and front hubs 22 and 22' of the first embodiment, this embodiment will not be discussed or illustrated in detail herein.

Referring to FIGS. 26 and 27, the rear hub 122 basically includes a hub axle 136, a hub body 138, a first bearing assembly 140a, a second bearing assembly 140b, a first spoke seal 142a, a second spoke seal 142b, a freewheel 144 and a quick release mechanism 146. The hub axle 136 has a center axis A extending between a first end 136a and a second end 136b.

The quick release mechanism 146 extends through a center bore 136c of the hub axle 136 such that the quick release mechanism 146 is coupled to the hub axle 136 in a conventional manner. The first and second ends 136a and 136b of the hub axle 136 are threaded for receiving a pair of nuts 150a and 150b that applies an axial force on the hub body 138, the bearing assemblies 140a and 140b, the spoke seals 142a and 142b, and the freewheel 144. First and second bearing assemblies 140a and 140b rotatably mount the hub body 138 with the freewheel 144 on the hub axle 136. The freewheel 144 allows the hub axle 136 to rotate



freely relative to the hub body **138** in one direction, but fixedly couples the hub axle **136** relative to the hub body **138** in the opposite rotational direction.

A set of first spoke openings **160a** are provided at the first end section **138a** of the hub body **138** for receiving the bent ends **24b** of the spokes **24**. Similarly, the second end section **138b** of the hub body **138** is provided with a second set of spoke openings **160b** for receiving the bent ends **24b** of the spokes **24**. In the illustrated embodiment, the first end section **138a** is provided with eighteen of the first spoke openings **160a** and the second end section **138b** is provided with eighteen of the second spoke openings **160b**. The spoke openings **160a** and **160b** are grouped into pairs that are equally spaced apart about the circumference of the hub body **138**. Accordingly, the rear hub **122** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **160a** and **160b** are arranged identical. The first and second spoke openings **160a** and **160b** are designed to be used with conventional tangential spokes **24**. Of course, it is possible that the first and second sets of spoke openings **160a** and **160b** can be different such that tangential spokes **24** are used in one end of the hub body **138** and a different types of spokes are used in the other end of the hub body **138**. The first spoke openings **160a** are circumferentially arranged around the hub body **138** adjacent to the brake rotor attachment portion **138d**. Preferably, the first spoke openings **160a** are spaced axially inward of the brake rotor attachment portion **138d** so that brake disc rotor **132** can be easily attached with the bolts **132a** and nuts **132b**.

In this embodiment, the spoke openings **160a** and **160b** are arranged to form two circumferential rows of spoke openings **160a** at end section **138a** and two circumferential rows of spoke openings **160b** at end section **138b**. Each of the spoke openings **160a** and **160b** has an insertion portion **161** and a retaining portion **162**. Adjacent pairs of the spoke openings **160a** and **160b** are oriented in opposite directions so that the spokes **24** extend in generally opposite directions from the hub body **138**.

Each insertion portion **161** is formed by a curved or partial cylindrical surface **164** that has a width or diameter that is equal to or slightly larger than the widths or diameters of the enlarged heads **24c** of the spokes **24**. Thus, the inner ends (bent ends **24b** with enlarged heads **24c**) of the spokes **24** can be easily inserted into the spoke openings **160a** and **160b** through the insertion portions **161**.

The retaining portions **162** have smaller widths or diameters than the insertion portions **161**. More specifically, the diameters or widths of the retaining portions **162** are smaller than the diameters or widths of the enlarged heads **24c** of the spokes **24** so as to retain the spokes **24** within the spoke openings **160a** and **160b**. The retaining portions **162** are each preferably defined by a partial cylindrical surface **166** that is connected to the curved surface **164** of the associated insertion portion **161**.

Preferably, the insertion portion **161** and the retaining portions **162** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **162** of the spoke openings **160a** and **160b** are tapered to avoid sharp edges engaging the spokes **24**.

Similar to the first embodiment, discussed above, each of the insertion portions **161** has a center longitudinal axis that passes through the center axis **A** of the hub axle **136**. The retaining portions **162**, on the other hand, have center longitudinal axes that are parallel to the center longitudinal

axis of the associated insertion portion **161** for each of the spoke openings **160a** and **160b**. Thus, the center longitudinal axes of the retaining portions **162** do not pass through the center axis of the hub axle **136**, similar to the first embodiment. Rather, the center longitudinal axes of the retaining portions **162** are angled with respect to center axis **A**. Preferably, the center longitudinal axis of each retaining portion **162** is angled between about  $5^\circ$  and about  $20^\circ$  from a radial orientation in the hub body **138**. In the illustrated embodiment, the retaining portions **162** are angled about  $10^\circ$  with respect to center axis **A** for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **162** are preferably angled about  $11^\circ$  with respect to center axis **A**. This angled configuration of the retaining portions **162** results in the straight sections **24a** of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **138**. Moreover, this angled configuration of the retaining portions **162** allows the straight sections **24a** of the spokes **24** to be easily aligned with the spoke holes of the rim without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees.

Referring to FIGS. **28** and **29**, the front hub **122'** basically includes a hub axle **136'**, a hub body **138'**, a first bearing assembly **140a'**, a second bearing assembly **140b'**, a first spoke seal **142a'**, a second spoke seal **142b'**, and a quick release mechanism **146'**. The hub axle **136'** has a center axis **A'** extending between a first end **136a'** and a second end **136b'**.

The quick release mechanism **146'** extends through a center bore **136c'** of the hub axle **136'** such that the quick release mechanism **146'** is coupled to the hub axle **136'** in a conventional manner. The first and second ends **136a'** and **136b'** of the hub axle **136'** are threaded for receiving a pair of nuts **150a'** and **150b'** that applies an axial force on the hub body **138'**, the bearing assemblies **140a'** and **140b'** and the spoke seals **142a'** and **142b'**. First and second bearing assemblies **140a'** and **140b'** rotatably mount the hub body **138'** on the hub axle **136'**.

A set of first spoke openings **160a'** are provided at the first end section **138a'** of the hub body **138'** for receiving the bent ends **24b** of the spokes **24**. Similarly, the second end section **138b'** of the hub body **138'** is provided with a second set of spoke openings **160b'** for receiving the bent ends **24b** of the spokes **24**. In the illustrated embodiment, the first end section **138a'** is provided with eighteen of the first spoke openings **160a'** and the second end section **138b'** is provided with eighteen of the second spoke openings **160b'**. The spoke openings **160a'** and **160b'** are grouped into pairs that are equally spaced apart about the circumference of the hub body **138'**. Accordingly, the front hub **122'** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

The first spoke openings **160a'** are circumferentially arranged around the hub body **138'** adjacent to the brake rotor attachment portion **138d'**. Preferably, the first spoke openings **160a'** are spaced axially inward of the brake rotor attachment portion **138d'** so that brake disc rotor **132'** can be easily attached with the bolts **132a'** and nuts **132b'**.

In this embodiment, the spoke openings **160a'** and **160b'** are arranged to form two circumferential rows of spoke openings **160a'** at end section **138a'** and two circumferential rows of spoke openings **160b'** at end section **138b'**. Each of



the spoke openings **160a'** and **160b'** has an insertion portion **161'** and a retaining portion **162'**. Adjacent pairs of the spoke openings **160a'** and **160b'** are oriented in opposite directions so that the spokes **24** extend in generally opposite directions from the hub body **138'**.

Each insertion portion **161'** is formed by a curved or partial cylindrical surface **164'** that has a width or diameter that is equal to or slightly larger than the widths or diameters of the enlarged heads **24c** of the spokes **24**. Thus, the inner ends (bent ends **24b** with enlarged heads **24c**) of the spokes **24** can be easily inserted into the spoke openings **160a'** and **160b'** through the insertion portions **161'**.

The retaining portions **162'** have smaller widths or diameters than the insertion portions **161'**. More specifically, the diameters or widths of the retaining portions **162'** are smaller than the diameters or widths of the enlarged heads **24c** of the spokes **24** so as to retain the spokes **24** within the spoke openings **160a'** and **160b'**. The retaining portions **162'** are each preferably defined by a partial cylindrical surface **166'** that is connected to the curved surface **164'** of the associated insertion portion **161'**.

Preferably, the insertion portion **161'** and the retaining portions **162'** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **162'** of the spoke openings **160a'** and **160b'** are tapered to avoid sharp edges engaging the spokes **24**.

Similar to the first embodiment, discussed above, each of the insertion portions **161'** has a center longitudinal axis that passes through the center axis **A'** of the hub axle **136'**. The retaining portions **162'**, on the other hand, have center longitudinal axes that are parallel to the center longitudinal axis of the associated insertion portion **161'** for each of the spoke openings **160a'** and **160b'**. Thus, the center longitudinal axes of the retaining portions **162'** do not pass through the center axis of the hub axle **136'**, similar to the first embodiment. Rather, the center longitudinal axes of the retaining portions **162'** are angled with respect to center axis **A'**. Preferably, the center longitudinal axis of each retaining portion **162'** is angled between about 5° and about 20° from a radial orientation in the hub body **138'**. In the illustrated embodiment, the retaining portions **162'** are angled about 10° with respect to center axis **A'** for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **162'** are preferably angled about 11° with respect to center axis **A'**. This angled configuration of the retaining portions **162'** results in the straight sections **24a** of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **138'**. Moreover, this angled configuration of the retaining portions **162'** allows the straight sections **24a** of the spokes **24** to be easily aligned with the spoke holes of the rim without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing description of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A bicycle hub for use with bicycle spokes, said bicycle hub comprising:
  - a hub axle having a center axis extending between a first end and a second end;
  - a hub body having an interior passageway with said hub axle being rotatably supported therein, a set of first spoke openings circumferentially arranged around said hub body, each of said first spoke openings having an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and a retaining portion with a width that is smaller than said width of said insertion portion to retain the enlarged head portion of the spoke therein; and
  - a seal structure arranged in said interior passageway of said hub body and adjacent said first spoke openings to isolate said first spoke openings from said hub axle, said seal structure including a first maintaining portion positioned to keep the spokes in said retaining portions of said first spoke openings.
2. A bicycle hub according to claim 1, wherein said first maintaining portion includes a resilient portion.
3. A bicycle hub according to claim 2, wherein said seal structure is positioned between said hub axle and said hub body to isolate a first interior section of said interior passageway adjacent said first spoke openings.
4. A bicycle hub according to claim 3, wherein said first interior section of said interior passageway is a continuous annular first space.
5. A bicycle hub according to claim 4, wherein said first maintaining portion includes a first flange with a first groove formed in its outer peripheral surface.
6. A bicycle hub according to claim 3, wherein said seal structure includes a first tubular section with said first maintaining portion being a first flange extending radially outward from said first tubular section.
7. A bicycle hub according to claim 6, wherein said first flange is annular flange that extends in a circumferential direction about said first tubular section.
8. A bicycle hub according to claim 1, wherein said first spoke openings extend through a tubular portion of said hub body in a generally radial direction.
9. A bicycle hub according to claim 8, wherein said seal structure includes a first tubular section with said first maintaining portion being a first flange extending radially outward from said first tubular section.
10. A bicycle hub according to claim 1, wherein said first maintaining portion is an annular flange that is positioned to keep spokes in said retaining portions of said first spoke openings.
11. A bicycle hub according to claim 8, wherein each of said first spoke openings includes an additional retaining portion to retain the enlarged head portions of two spokes with in each of said first spoke openings.
12. A bicycle hub according to claim 11, wherein said seal structure includes a first tubular section with said first maintaining portion being a first flange extending radially outward from said first tubular section.
13. A bicycle hub according to claim 12, wherein said first flange is an annular flange with said first maintaining portion being positioned between ends of said first tubular section to axially separate said insertion portions from said retaining portions of each of said first spoke openings.



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14. A bicycle hub according to claim 1, wherein said first spoke openings are arranged to form an outer circumferential row of said first spoke openings and an inner circumferential row of said first spoke openings that is axially spaced along said hub body from said outer circumferential row of said first spoke openings, said outer and inner circumferential rows of said first spoke openings are arranged to form a pair of said first spoke openings comprising one of said first spoke openings of said outer circumferential row and one of said first spoke openings of said inner circumferential row.
15. A bicycle hub according to claim 1, further comprising a freewheel coupled to said second end of said axle adjacent said second end section of said hub body.
16. A bicycle hub according to claim 1, wherein said hub body further includes a set of second spoke openings circumferentially arranged around said hub body at a location that is axially spaced from said first spoke openings, each of said second spoke openings having an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and a retaining portion with a width that is smaller than said width of said insertion portion of said second spoke openings to retain the enlarged head portion of the spoke therein, and said seal structure further being arranged in said interior passageway of said hub body and adjacent said second spoke openings to isolate said second spoke openings from said hub axle, said seal structure further includes a second maintaining portion being further positioned to keep the spokes in said retaining portions of said second spoke openings.
17. A bicycle hub according to claim 3, wherein said hub body further includes a set of second spoke openings circumferentially arranged around said hub body at a location that is axially spaced from said first spoke openings, each of said second spoke openings having an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and a retaining portion with a width that is smaller than said width of said insertion portion of said second spoke openings to retain the enlarged head portion of the spoke therein, and said seal structure is further positioned between said hub axle and said hub body to isolate a second interior section of said interior passageway adjacent said second spoke openings, said seal structure further includes a second maintaining portion being positioned to keep the spokes in said retaining portions of said second spoke openings.
18. A bicycle hub according to claim 17, wherein said seal structure includes first and second sealing portions with said first sealing portion being a separate member from said second sealing portion.
19. A bicycle hub according to claim 18, wherein said first interior section of said interior passageway includes a first continuous annular first space, and said second interior section of said interior passageway includes a second continuous annular second space.
20. A bicycle hub according to claim 17, wherein said first maintaining portion includes a first resilient flange with a first groove formed in its outer peripheral surface, and said second maintaining portion includes a second resilient flange with a second groove formed in its outer peripheral surface.

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21. A bicycle hub according to claim 20, wherein each of said first and second resilient flanges extend radially outward from a corresponding tubular section.
22. A bicycle hub according to claim 21, wherein said flanges are annular flanges that extends in a circumferential direction about its corresponding said tubular section.
23. A bicycle hub according to claim 18, wherein each of said second spoke openings has an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and retaining portion with a width that is smaller than said width of said insertion portion of said second spoke openings to retain the enlarged head portion of the spoke therein.
24. A bicycle hub according to claim 23, wherein said first and second spoke openings extend through a tubular portion of said hub body in a generally radial direction.
25. A bicycle hub according to claim 24, wherein said first sealing portion includes a first tubular section with said first maintaining portion being a first flange that extends radially outward from said first tubular section, and said second sealing portion includes a second tubular section with said first maintaining portion being a second flange that extends radially outward from said second tubular section.
26. A bicycle hub according to claim 25, wherein said first flange is an annular flange that is positioned to keep spokes in said retaining portions of said first spoke openings, and said second flange is an annular flange that is positioned to keep spokes in said retaining portions of said second spoke openings.
27. A bicycle hub for use with bicycle spokes, said bicycle hub comprising:  
a hub axle having a center axis extending between a first end and second end;  
a hub body having an interior passageway with said hub axle being rotatably supported therein, a set of first spoke openings formed said hub body and arranged circumferentially around said hub body, each of said first spoke openings having an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and, retaining portion with a width that is smaller than said width of said insertion portion to retain the enlarged head portion of the spoke therein; and  
a seal arranged in said interior passageway to form a first isolated space of said interior passageway below said first spoke openings, said seal including a maintaining portion positioned to keep the spokes in said retaining portions of said first spoke openings.
28. A bicycle hub according to claim 27, wherein each of said first and second spoke openings includes an additional retaining portion to retain the enlarged head portions of two spokes with in each of said first and second spoke openings.
29. A bicycle hub according to claim 28, wherein said first isolated space of said interior passageway is a continuous annular first space.
30. A bicycle hub according to claim 29, wherein said seal includes a first tubular section with said first maintaining portion being a first flange extending radially outward from said first tubular section.